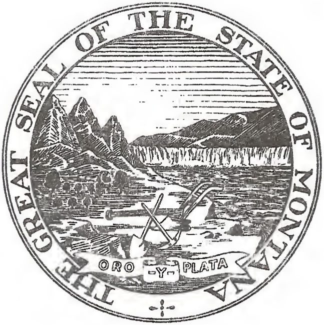

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MONTANA'S MAJOR ENERGY TRANSPORTATION SYSTEMS:

CURRENT CONDITIONS AND FUTURE DEVELOPMENTS

Prepared for

Montana Energy Advisory Council

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TABLE OF CONTENTS

I

MAJOR ENERGY TRANSPORTATION SYSTEMS IN MONTANA

Coal Transportation Systems

Coal mining has become one of the major--and certainly the most controversial--energy producing industry in Montana. As shown in table 1.1, the state's coal production has increased from about 3.5 million tons in 1970 to approximately 22.2 million tons in 1975. Most is shipped out-of-state; during 1975, only 1.2 million tons, about five percent of the total, was consumed in Montana.

This section takes a closer look at Montana's coal transportation systems. First, domestic consumption will be examined by describing the supply methods for Montana's coal-fired electric generating plants and other coal using industries. Then, turning to the export market, the important features of unit trains will be discussed.

Instate Consumption of Coal

The major instate users of Montana coal are the four coal-fired electric generating plants in the state. Three are operated by The Montana Power Company, the Corette plant at Billings and Units I and II at Colstrip, while the fourth is the Lewis and Clark generating plant at Sidney owned and operated by the Montana-Dakota Utilities. The Montana Power Company installations are supplied with coal from the Western Energy Company (a subsidiary of The Montana Power Company) at Colstrip while the Knife River Coal Company (a subsidiary of the Montana-Dakota Utilities) mine near Savage provides the fuel for the generation plant at Sidney.

Table 1.1

Montana Coal Production, 1970-1975

(In Thousands of Short Tons)

Year	Production	Shipped from Montana	Consumed in Montana
1970	3,517	--	--
1971	7,097	--	--
1972	8,264	--	--
1973	10,729	--	--
1974	14,124	13,279	845[a]
1975	22,162	20,956	1,206[a]

Source: Terry Wheeling, *Montana Historical Energy Statistics* (Helena, Montana: Montana Energy Advisory Council, 1976), tables 5.3 and 5.9.

--denotes that the data are not available.

[a]Excludes coal transported into Montana.

Coal from the Western Energy Company mine is loaded onto trucks and transported about three miles to a primary and secondary crusher which reduces the pieces to a maximum diameter of one and one-half inches. The coal may then be placed on railroad cars for shipment to the Corette plant or onto a conveyor leading to Colstrip Units I and II.

The coal destined for the Corette plant is routed from the crusher into hopper cars. When about 57 cars have been filled, the Burlington Northern is notified and they are transported to Billings. On the average, about 100 shipments of 57 cars each are required each year to supply the 550,000 tons of coal consumed in the Corette plant.

The coal for Colstrip Units I and II is transferred from the crusher onto a 1,400 foot conveyor to a storage area adjacent to the plants. When they are in full operation, a total of approximately 2.6 to 3.0 million tons per year will be consumed by these two generating facilities. It is anticipated that this conveyor system will also be adequate for the proposed Colstrip Units III and IV; only the addition of a crusher will be required.

The Montana-Dakota Utilities' electric generating plant at Sidney consumes about 300,000 tons per year of low BTU lignite coal. It is extracted from a surface mine at Savage and is transported about 22 miles by rail. At the mine, the coal is trucked a short distance to the railroad spur and loaded into hopper cars. Then, the Burlington Northern is responsible for the trip from Savage to the plant at Sidney.

Neither the Colstrip-to-Billings nor the Savage-to-Sidney shipments of coal are via unit trains. That is, they do not use dedicated equipment on a strict schedule. Instead, they are considered point-to-point hauls and the freight rates are negotiated with the railroad and approved by the Montana Public Service Commission.

The largest coal consumers in Montana (other than electrical generating plants) are the Ideal Cement plant at Trident, and the American Smelting and Refining Company (ASARCO) at East Helena. Neither facility uses Montana coal. Rather, it is transported into Montana via the Union Pacific rail line from Idaho Falls, Idaho, to Butte, and then to the plant sites on the Burlington Northern (see figure 1.1).

The ASARCO plant consumes about 40,000 tons per year. Typical delivery would be two sets of five 80-ton cars per week (800 tons per week). Since October 1976, coal produced from an underground mine in central Utah, which averages about 12,500 BTU per pound, has been used. Previously, similar coal was supplied from an underground mine in Colorado.

Ideal Cement consumes about 300 to 325 tons per day (110,000 to 120,000 tons per year) of roughly 10,500 BTU per pound coal from an underground mine near Rock Springs, Wyoming. Typical size of shipments is twelve 80- to 90-ton cars, arriving twice per week.

In addition, small amounts of Wyoming and Utah coal have been carried into Montana via the Union Pacific line for retail sales in the Dillon area. The U.S. Bureau of Mines estimates these imports to have been about 9,000 tons in 1974 and about 7,000 tons in 1975.[1]

The possibility of reduced supplies and the rising price of natural gas have led several Montana industries to substitute coal as an alternate energy source. The Great Western Sugar Company plant near Billings is well underway in its conversion from natural gas to coal as a boiler fuel. Approximately 500 tons per day of 9,500 BTU coal will be used to fire

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[1] U.S. Department of the Interior, Bureau of Mines, *Bituminous Coal and Lignite Distribution* (Washington, D.C., U.S. Government Printing Office: 1976), tables I and II.

three boilers, beginning in October 1977. The plant operates about 140 days per year (October to March), and will use about 70,000 tons of coal per year. Contracts have not yet been signed, but it is expected that coal stripmined near Sheridan, Wyoming, will be used. In that event, delivery would be by the Burlington Northern line from Sheridan to Billings, consisting of shipments of about ten 50-ton cars per day during the plant's operational months.

The Kaiser Cement plant at Montana City (near Helena) is currently considering conversion to coal, depending on future developments in natural gas prices and availability. It is estimated that this facility may annually use about 80,000 to 90,000 tons of 10,000 BTU Wyoming or Utah coal, which may be shipped via the Union Pacific Railroad to Butte and transferred to the Burlington Northern and for delivery to the plant site.[2]

Coal for Export; the Unit Train

Montana's coal is shipped to midwestern utilities for use in electric generation plants. Despite its low energy content relative to eastern coal and the fact that it must be transported long distances, Montana coal is competitive because its low-sulfur content enables these utilities to comply with local pollution requirements. During 1975, the largest buyers of Montana coal were in Illinois, receiving about 9.5 million tons, Minnesota, approximately 6.3 million tons, and Wisconsin, 2.5 million tons.[3]

[2]Henningson, Durham, and Richardson, Inc., *Energy and Secondary Materials Market Report* (Helena, Montana, Department of Health and Environmental Sciences: 1976), p. II-19.

[3]Terry Wheeling, *Montana Historical Energy Statistics* (Helena, Montana: Montana Energy Advisory Council, 1976), table 5.6.

Most buyers have made a long term commitment to Montana coal; contracts call for the delivery of millions of tons of coal over twenty years or more.

Montana's export coal is shipped to the utilities via unit train. In the strict sense, a unit train refers to a group of dedicated cars operating on a regular schedule between two points. In actual practice, however, the origin and destination may not be identical on every trip. For example, a unit train may transport coal from a mine to a generating plant and return to the mine. Then, after it is reloaded, it may be routed to another destination.[4]

The 10,000 ton unit train--100 identical cars each with a capacity of 100 tons--has become a standard for coal shipments from the northern great plains. Using such a train, about 220 round-trips per year are required to ship the 2.2 million tons of coal consumed by a 500 MW electrical generating plant--a plant roughly half-way between the 330 MW Colstrip I and II plants and the proposed 700 MW Colstrip III and IV plants. Stated differently, transporting one million tons of coal per year requires about 200 trains per year (100 loaded and 100 empty) passing a given point along the route.

Despite the often heard claims concerning the low costs of unit trains, exact cost figures are not available because the rate-setting authority, the U.S. Interstate Commerce Commission, has not established a tariff for this classification. Each contract is negotiated between the buyer, seller, and the railroad and may include features which are unique or not applicable to other situations. Table 1.2 summarizes some of the features of recent

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[4] T.C. Campbell and Sidney Katell, U.S. Department of the Interior, Bureau of Mines, *Long Distance Coal Transport: Unit Trains or Slurry Pipelines*, Information of Fuels for Utility Consumption (Henniker, New Hampshire, 1976), p. 3.

Table 1.2

Summary of Selected Coal Delivery Contracts

Origin and Destination	Effective Date	Minimum Train Load	Annual Minimum Tonnage	Rate per Ton	Distance Transported (Miles)	Cost per Ton-Mile
Colstrip, Montana to Cohasset, Minnesota	8-13-73	10,200	1,000,000 1,500,000 1,750,000	\$3.69 3.45 3.23	773	\$0.0048 0.0045 0.0042
Colstrip, Montana to Wautegan, Illinois	1-22-73	10,000	450,000[a] 900,000[b]	8.38 8.60	1,250 1,273	0.0067 0.0068
Decker, Montana to Havana, Illinois	7-1-73	9,700	3,300,000	8.62	1,168	0.0074
Kleenburn, Wyoming to St. Paul, Minnesota	8-13-73	5,300	200,000	6.09	1,105	0.0055

Source: T. C. Campbell and Sidney Katell, U.S. Department of the Interior, Bureau of Mines, *Long Distance Coal Transport: Unit Train or Slurry Pipeline,* Information Circular 8690 (Washington, D.C.: U.S. Government Printing Office, 1976), p. 14.

[a]One destination.

[b]Two destinations.

contracts for Montana and Wyoming coal; the associated rate per ton and costs per ton mile are also shown.

The cost of unit trains from the economies of transporting a single commodity between two points. High speed loading and unloading equipment minimizes idle time at the origin and destination. Unit trains require a minimum of classification--that is, there is no need to break up the train even if it is moved through yards enroute. As a result, unit trains typically experience turnaround times of one-third to one-fifth the average for conventional trains and car utilization can reach 80 percent as compared to the nationwide average of 12 percent for all freight cars.[5] The principal disadvantage of unit trains is that the return trip is usually empty.

Many of the hopper cars in unit trains are owned or leased by the buyers or sellers of the coal rather than the railroad. Some of the advantages of this procedure are as follows:

1. Cars are less likely to be diverted to other uses in times of emergency or extreme car shortages.

2. The mine is assured of being able to load cars previously loaded with coal, thereby minimizing the need for cleaning.

3. Cars can be designed for the specific service.

4. Ownership of the cars can be a factor in negotiating long-term contracts at a delivered price.[6] That is, freight rates may be lower when the coal is shipped in cars owned or leased by a party other than the railroad.

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[5] Willard D. Weiss and Ronald Dunn, "Modern Railroad Concepts for Transporting Western Coal," a paper presented at Engineering Foundation Conference on Transportation of Fuels for Utility Consumption (Henniker, New Hampshire, 1976), p. 3.

[6] T.C. Campbell and Sidney Katell, *Long Distance Coal Transport: Unit Train or Slurry Pipelines*, pp. 12-13.

The Burlington Northern currently transports all of Montana's export coal. The important railroad lines in Montana are shown in figure 1.1. The major coal-loading points are the Western Energy Company and Peabody Coal Company mines served by the Nichols spur west of Forsyth, the Westmoreland Resource Mine along the Hysham line, and the Decker Coal Company situated just north of the Montana-Wyoming border on a branch line from Sheridan, Wyoming. All of the export coal from the Western Energy, Peabody, and Westmoreland mines--about 12.5 million tons in 1975--is shipped east along the old Northern Pacific mainline through Forsyth, Glendive, and into North Dakota near Beach. Coal from the Decker Coal Company mine is transported over two routes; during 1975, approximately 8.2 million tons was shipped south through Wyoming and Nebraska, and about 1.1 million tons passed through Sheridan and north to Huntley, Montana, and then east along the old Northern Pacific mainline.

The number of railroad jobs in Montana associated with coal unit trains is difficult to determine because these workers, unlike rolling stock, are not permanently assigned to specific tasks. The crew of a unit train usually consists of four persons, an engineer, a conductor, and two brakemen. In addition, there are maintenance workers, signalmen, and other personnel along the right-of-way. Taking all these factors into consideration, Burlington Northern estimates there were about 214 full-time equivalent (FTE) railroad jobs in Montana during associated with unit coal trains.[7] The average annual earnings of a railroad employee in Montana during 1975

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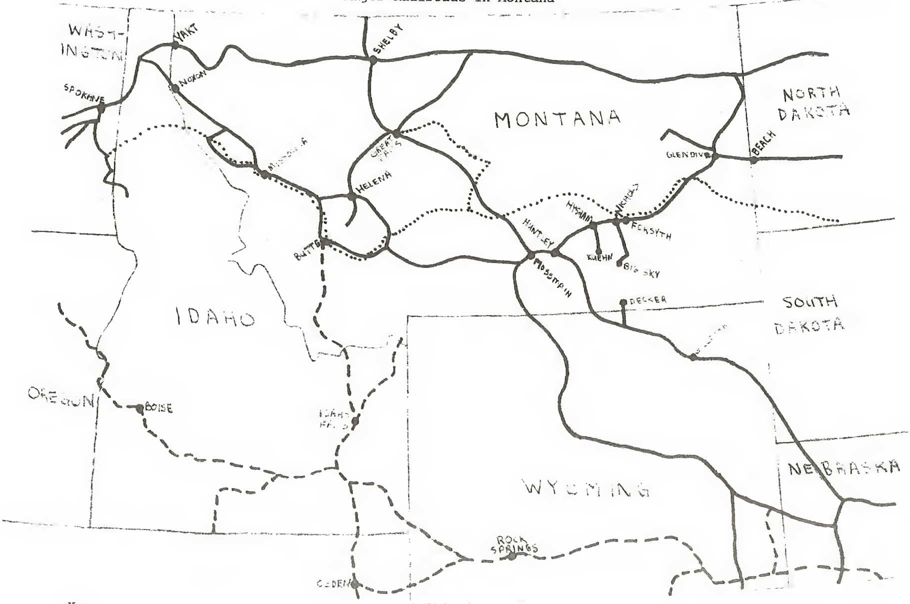
[7]John Willard, Public Relations Manager, Burlington Northern, Billings, Montana, Personal correspondence, October 19, 1976.

Figure 1.1

Major Railroads in Montana



Key

—— Burlington-Northern
– – – Union Pacific
······ Chicago, Milwaukee, St. Paul & Pacific

was $16,200 per year, making them among the highest paid workers in the state and an important part of the economic base.[8]

Electrical Transmission Systems

Montana's electrical transmission lines are interconnected with other transmission systems to the east, south, and west to form a "grid" system. These interconnections maximize the reliability of power delivery by using alternate transmission paths should a given line fail and minimize the necessity of reserve generating capacity (to meet peak demands) by shifting energy flows in response to varying daily and seasonal demands. Montana lies between two giant regional grid systems, one administered by the Western Systems Coordinating Council (WSCC) and the other by the Mid-Central Area Reliability Council Agreement (MARCA).

The major steps in the transmission and distribution of electric energy are shown in figure 1.2. Typically, electric energy is generated at a much lower voltage than is desirable for bulk transmission. In order to reduce transmission losses, the voltage is increased, to 230,000 volts (230 KV) or higher, for long distance transmission and then reduced for distribution to users. To prevent interruptions when a particular line fails, a transmission system usually includes a second line which can deliver the total required load to a given demand center. These lines typically follow different routes, or "corridors", to minimize the chances of both failing at the same time.

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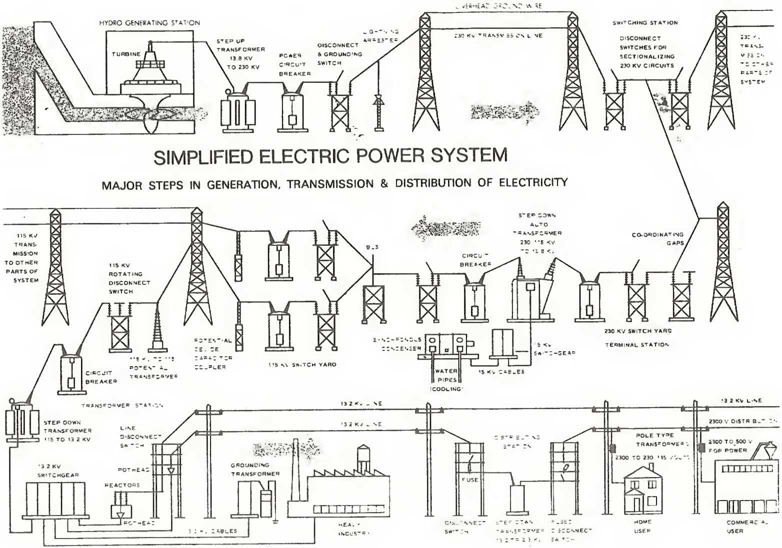
[8] U.S. Department of Commerce, *Survey of Current Business*, Vol. 56, No. 8 (August 1976), p. 26. Montana Department of Labor and Industry, *Montana Employment and Labor Force* (Helena, Montana, March 1976), table C.

Figure 1.2


SIMPLIFIED ELECTRIC POWER SYSTEM
MAJOR STEPS IN GENERATION, TRANSMISSION & DISTRIBUTION OF ELECTRICITY
HYDRO GENERATING STATION
TURBINE
STEP UP TRANSFORMER 13.8 KV TO 230 KV
POWER CIRCUIT BREAKER
DISCONNECT & GROUNDING SWITCH
SWITCHING STATION
DISCONNECT SWITCHES FOR SECTIONALIZING 230 KV CIRCUITS
115 KV TRANSMISSION TO OTHER PARTS OF SYSTEM
115 KV ROTATING DISCONNECT SWITCH
CIRCUIT BREAKER
STEP DOWN AUTO TRANSFORMER
CO-ORDINATING GAPS
230 KV SWITCH YARD
TERMINAL STATION
115 KV SWITCH YARD
WATER PIPES (COOLING)
STEP DOWN TRANSFORMER 115 TO 13.2 KV
13.2 KV SWITCHGEAR
LINE DISCONNECT SWITCH
POTHEAD
REACTORS
GROUNDING TRANSFORMER
13.2 KV LINE
POLE TYPE TRANSFORMERS
2300 TO 500 V FOR POWER
FUSE
HOME USER
COMMERCIAL USER

Montana is now serviced by a 230 KV alternating current (AC), overhead transmission (OHT) system for bulk electrical transmission. This system is composed of both federally-owned and privately-owned lines. (See figure 1.3). The Bonneville Power Administration (BPA), a federal agency established to sell electric energy generated by federal dams in the pacific northwest, is currently constructing a 500 KV grid system to overlay its present lower voltage transmission system. The only 500 KV line in Montana, owned by BPA and running from Hot Springs, Montana, to Washington State, is part of that system. Also, the proposed Colstrip to Hot Springs dual 500 KV line would tie into the BPA system and be compatible with it. In addition to the major transmission lines shown in figure 1.3, several 100 KV lines and an intricate web of low voltage distribution lines provide service to almost every location in the state. As of the end of 1974, the Edison Electric Institute (EEI) reports Montana had 8,946 circuit miles of overhead transmission lines of 22 KV or greater.[9] Of this total, about 6,976 circuit miles were owned by private utilities and 1,970 circuit miles were owned by public utilities.

Most electric energy consumed in eastern Montana is generated at Montana-Dakota Utilities' (MDU) plants and the U.S. Bureau of Reclamation (BR) hydroelectric facilities at Fort Peck and Yellowtail Dams. The major transmission lines are owned by BR, with electricity supplied to MDU distribution systems throughout eastern Montana. Central Montana is served by The Montana Power Company (MPC), with electricity from other utilities and from MPC steam and hydro generation plants, transmitted over MPC lines.

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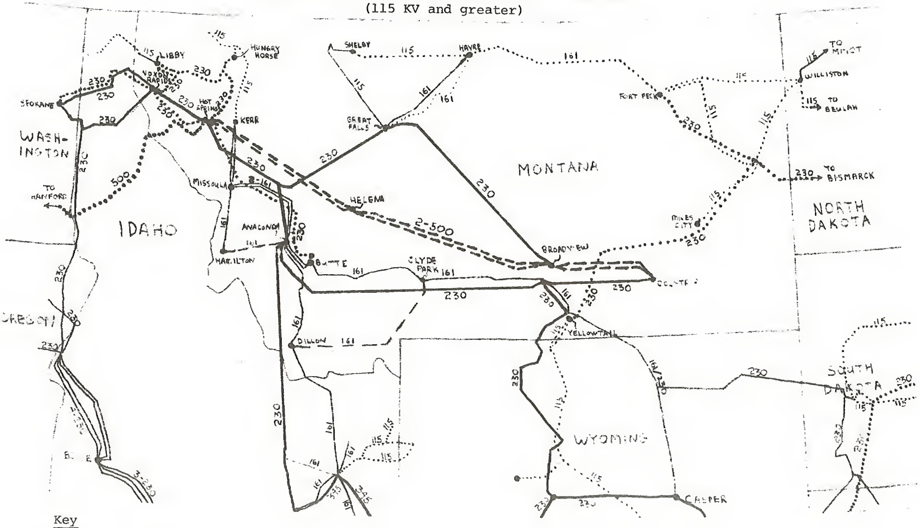
[9]Edison Electric Institute, *Statistical Year Book of the Electric Utility Industry for 1974* (New York, New York, 1975), tables 485 and 495.

Figure 1.3

Major Electrical Transmission Lines in Montana
(115 KV and greater)



Key

- ······ Federal Facilities
- ——— Private Facilities
- — — Proposed Montana Power Company Lines

(Numbers indicate size of line in kilovolts)

The western portion of the state is served by MPC, Pacific Power and Light Company, and federal agencies including BPA and BR. The Washington Water Power Company also generates power at the Noxon Rapids Dam, with most transmitted west to the Spokane area. In addition, twenty-five cooperatives, members of the Rural Electric Cooperatives Association (REA), are responsible for distribution of electricity in Montana.

Electricity is transferred between the various organizations responsible for distribution under several types of agreements. Available electricity may be purchased directly, or it can be received by one utility system from another in exchange for electricity to be delivered at a different time and/or place (called "interchange" energy). In addition, "wheeling" agreements enable the transmission of large blocks of electricity over the transmission system of another utility to the point of demand. These agreements permit better use of existing facilities and avoid expensive duplication of transmission lines. The facilities of BPA and BR are used extensively for wheeling power to the customers of private utilities.

As mentioned above, Montana is contained within two regional grid systems; the western and central portions of the state in WSCC and the eastern portion in MARCA. The interconnection between these systems is a 230 KV line owned by BR from Yellowtail Dam to North Dakota. This link is considered to be very unstable and normally remains "opened" by the circuit breakers at Yellowtail Dam. There is, however, some flexibility in using the electricity generated at both Yellowtail and Fort Peck Dams, since these facilities can simultaneously input into both the WSCC and MARCA grids in varying ratios. Thus, even though electricity is not normally transmitted between the two regional grid systems in Montana, energy from the two BR dams can be directed into either (or both) as needed.

The flow of electric energy in Montana has usually been from west to east. This was due to imports from the BPA system into western Montana and exports from the BR dams in eastern Montana to North Dakota. Montana's net flow of electricity may be estimated by comparing annual generation in the state, less typical transmission losses, with annual consumption of electricity. Transmission and distribution losses for MPC during 1975 were reported to the U.S. Federal Power Commission as about ten percent.[10] (Losses for bulk transmission of high voltage electric energy in a system such as BPA would be closer to five percent.) Using data reported by the Edison Electric Institute (EEI), 1974 Montana generation was 11.1 billion kilowatt-hours (kwh); less ten percent yields 10.0 billion kwh.[11] This compares to 1974 Montana sales of 9.5 billion kwh (as reported by EEI), giving a net Montana export of about 0.5 billion kwh. For 1975, preliminary EEI data reports generation of 11.3 billion kwh in Montana, less ten percent yields 10.2 billion kwh, and sales in Montana of 8.9 billion kwh, indicating an approximate net export from Montana of about 1.3 billion kwh. With the addition of Colstrip Units III and IV to the state's generating capacity, exports of electric energy may substantially increase and Montana may become an exporter of electric energy to both the east and west.

Crude Oil Pipeline Systems

Pipelines are the most efficient overland method to transport large volumes of crude oil. Virtually all crude oil movements within Montana are

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[10] The Montana Power Company, *Annual Report to the Federal Power Commission for 1975* (Butte, Montana, 1976), page 431.

[11] Edison Electric Institute, *Statistical Year Book of the Electric Utility Industry for 1975, Advance Release* (New York, New York, 1976), pp. 5 and 10.

by pipelines, ranging from small diameter gathering lines (two inches to four inches) receiving oil at the wellhead to larger diameter trunk lines (eight inches to sixteen inches) delivering oil to refineries. Due to the large investment necessary for the construction of major pipelines, exploration for and production of crude oil is constrained by the location of existing trunk lines. Further, since the long run costs of shipping crude oil by highway or rail may be prohibitive (except for very short distances), the sources for refineries are limited by the available pipeline systems. The existing pipeline network, then, plays a fundamental role in determining the flow of crude oil in the state and the region. Since most of Montana's crude oil production occurs in the eastern part of the state, which has no pipeline connection to the major refineries located in the Billings area, this oil is not available for refining in Montana and is shipped to other states.

The data in table 1.3 show that Montana both imports and exports substantial volumes of crude oil. The major crude oil pipelines in the United States are pictured in figure 1.4. A detailed map of the pipelines in Montana is included in the back of this report. Two major pipeline systems transport crude oil in the state. One is located along the eastern edge of the state while the other runs through central Montana. The general flow of both systems is from north to south. The eastern system is composed of three interconnected pipelines: The Wascana Pipeline (Regina, Saskatchwan, to Poplar), the Western Crude Oil Pipeline (Poplar to Baker), and the Butte Pipeline (Baker to Guernsey, Wyoming). This pipeline system mostly ships crude oil produced in eastern Montana to refineries in the midwest. The central Montana pipeline system is composed of the Glacier Pipeline (Canada to Byron, Wyoming), the Phillips Pipeline (Cut Bank to Great Falls),

Table 1.3

Montana Imports and Exports of Crude Oil, 1970-1975

(In Thousands of Barrels)

Year	Imports to Montana Refineries 2/ From Canada	From Wyoming	Exports from Montana To Other States 1,3/
1970	19,342	13,908	17,982
1971	19,732	16,003	15,032
1972	19,241	21,156	15,439
1973	18,235	24,295	22,591
1974	16,949	23,115	22,638
1975	19,465	20,690	20,513

1/ See Table 1.4 for distribution of crude oil exports by state for 1973-1975.

2/ Source: Terry Wheeling, *Montana Historical Energy Statistics* (Helena, Montana: Montana Energy Advisory Council, 1976), Table 4.5.

3/ Source: Terry Wheeling, *Montana Historical Energy Statistics* (Helena, Montana: Montana Energy Advisory Council, 1976), Table 4.6.

Figure 1.4. Major U.S. Crude Oil Supply Pipelines

Table 1.4

Distribution of Montana Crude Oil Exports

by State of Destination

(Thousand Barrels)

Destination	1973	1974	1975
Pennsylvania	346	360	769
Illinois	3,096	2,608	2,236
Indiana	13,720	14,435	10,907
Kansas	1,638	1,065	1,020
Minnesota, Wisconsin	1,199	1,617	2,026
Missouri, Nebraska	0	80	654
North Dakota	1,065	1,374	1,304
Ohio	80	115	59
Oklahoma	0	50	0
Colorado	793	573	256
Wyoming	654	361	498
Utah	0	0	784
Total	22,591	22,638	20,513

Source: Terry Wheeling, *Montana Historical Energy Statistics* (Helena, Montana: Montana Energy Advisory Council, 1976), Table 4.7.

and the Exxon Oil Pipeline (Wyoming to Billings). They deliver crude oil produced in Canada, Wyoming, and Montana to central Montana refineries. The size, capacity, and average throughput for these pipelines are shown in table 1.5.

The Wascana Pipeline carries crude oil from its junction with the Interprovincial Pipeline in Regina, Saskatchewan, over a 12-inch line to Poplar where it joins the ten inch Western Crude Oil Pipeline. The Canadian government has announced that exports of crude oil will be phased out in the near future, and has begun to reduce the volumes flowing to the United States. In response, the U.S. Federal Energy Administration (FEA) has established a priority system to determine which refineries should receive the remaining Canadian imports. The Wascana Pipeline carries crude to Priority II (the lowest classification) refiners only, and consequently its shipments of crude oil have been significantly reduced. During November of 1976, the average flow of crude oil in the Wascana Pipeline from Canada was about 350 barrels per day (bpd), about one percent of capacity.[12] According to the current schedule, shipments of Canadian crude oil over the Wascana line will cease at the end of 1976. The Wascana Pipeline Company has announced plans to reverse the direction of flow so that crude oil may be shipped from Poplar to Regina. This alteration is minor and may be completed in early 1977. It is expected that the pipeline will ship about 1,500 bpd of Montana crude north to Regina for transfer to the Interprovincial Pipeline and delivery to the Minneapolis area. Wascana is a sponsor of the proposed Northern Tier Pipeline to carry crude oil from Puget Sound through

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[12] Wascana Pipeline Company, Denver, Colorado, personal communication with Terry Wheeling, Montana Energy Advisory Council, Helena, Montana, November 1976.

Table 1.5

Montana Crude Oil Pipeline Data

(In Thousand Barrels Per Calendar Day)

Pipeline	From	To	Diameter (inches)	Capacity (MBCD)	Thruput[a/] (MBCD)	Source
Wascana	Regina, Sask.	Poplar	12	35.0	0.35(11/76)	1,4
Western Crude Oil	Poplar	Baker	10	NA	7.0	4
Butte	Baker	Alzada	16	70.0	49.2	1
	Alzada	Osage, Wyo.	16	90.0	54.8	1
	Osage, Wyo.	Guernsey, Wyo.	16	128.0	83.8	1
Portal	Culbertson	Grenora, N.D.	6	27.9	7.3(7/76)	1
Continental Oil	Alberta	Cut Bank	2-12	88.0	55.0	1,2
	Alberta	Cut Bank	8	30.0	15.0	1,2
	Cut Bank	Billings	12	62.0	53.9	1,2
	Cut Bank	Roundup	8	33.4	17.5	1,2
	Roundup	Billings	10	44.0	28.0	1,2
	Billings	Laurel	4,8	48.3	16.0	1,2
	Laurel	Byron, Wyo.	8	38.3[b/]	11.4	1,2
Phillips Petroleum	Cut Bank	Great Falls	5	6.5	5.9	1
Exxon Oil	Wyoming	Billings	12	64.0	49.5	1,3

Sources:
1. Bonner and Moore Associates, Inc., *Petroleum Supply Alternatives for the Northern Tier States* (Houston, Texas, 1976) Volume III, Addendum B, Transportation.
2. Continental Pipeline Company, *Annual Report to the Interstate Commerce Commission for 1975* (Ponca City, Oklahoma, 1976), Schedule 400.
3. Exxon Pipeline Company, *Annual Report to the Interstate Commerce Commission for 1975* (Houston, Texas, 1976), Schedule 400.
4. Wascana Pipeline Company, Denver, Colorado, personal communication to Terry Wheeling, Montana Energy Advisory Council, Helena, Montana, November, 1976.

a/ Data is average for 1975 unless otherwise indicated.

b/ Work was completed in 1976 to "yo-yo" this line, which will enable delivery of up to 13,000 barrels per day of crude from Byron to Laurel.

NA Not Available.

Montana to Minnesota. If built, the Wascana Pipeline Company expects to receive Alaskan crude oil near Poplar (up to 35,000 bpd) and transport it north over the Wascana line.

The Western Crude Oil Pipeline connects the Wascana and Butte Pipelines, and receives crude oil from fields in Richland, Dawson, McLane, and Wibaux counties. The expected reversal of the Wascana line would decrease the flow through this pipeline by 1,500 bpd. If the Northern Tier Pipeline is built, Alaskan crude oil could be transferred to the Western Crude Oil line for transport to the south.

The Butte Pipeline from Baker to Guernsey, Wyoming, carries crude oil from both the Williston Basin in northeastern Montana and from the Powder River Basin in southeastern Montana. The pipeline connects with the Platte Pipeline at Guernsey, which then delivers crude oil to refineries in the Great Lakes area.

The Portal Pipeline, a small six inch pipeline owned by Burlington Northern, ships crude oil produced in the northeast corner of Montana to Grenora, North Dakota. From there, the Portal system carries crude oil to Clearbrook, Minnesota, and connects with the Minnesota Pipeline for delivery to the Minneapolis area.

The Glacier Pipeline system, owned and operated by the Continental Oil Company, is the major pipeline system delivering crude oil to Montana refineries. Two parallel pipelines, an eight inch and a twelve inch, connect with the Rangeland Pipeline system at the Montana-Alberta border. The system carries Canadian crude oil and natural gas condensates, as well as northern Montana crude oil from the Cut Bank area, to the three major refineries in the Billings area and south into Wyoming. The Glacier system

also gathers the crude oil from fields in central Montana for delivery to Billings.

Two other crude oil pipelines interconnect with the Continental Oil Pipeline system. First, parelleling the Glacier line from the Cut Bank area to Great Falls, the Phillips Petroleum Pipeline can receive Canadian oil from the Continental line, plus northern Montana crude oil, for delivery to the Phillips Petroleum Company refinery in Great Falls. Second, the Exxon Pipeline delivers crude oil from the Big Horn Basin in Wyoming and southcentral Montana to the Billings area refineries.

The Continental Oil Pipeline Company has recently (October 1976) completed modifications to the Billings to Byron, Wyoming, sections of the Glacier system allowing crude oil to be shipped in both directions (called a "yo-yo" line). Previously, Canadian crude oil was transported south to Wyoming on this line. Due to the Canadian curtailment, these shipments are expected to cease in January 1977 and lead to excess capacity in this pipeline. The Continental Oil Pipeline Company expects to be able to deliver from Wyoming up to 12 to 13 thousand bpd of crude oil to the Laurel and Billings refineries.

According to data from the Montana Petroleum Association, 62 full-time operation and maintenance personnel are currently employed by the major crude oil pipeline companies in Montana.[13]

Petroleum Products Pipleine Systems

Petroleum products pipelines in Montana ship the "lighter" portions of refined products (gasoline, kerosene, diesel fuel, etc.) from the

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[13] The Montana Petroleum Association, Billings, Montana, personal communication with Terry Wheeling, Montana Energy Advisory Council, Helena, Montana, November 1976.

three refineries in the Billings area to terminals in Montana, Washington, North Dakota and Wyoming.

At the pipeline terminals, these products are mixed with company-specific fuel additives and then trucked to wholesale and retail sales outlets. The other Montana refineries at Great Falls, Cut Bank, Kevin, and Wolf Point do not have access to products pipelines and rely on trucks for distribution of their refined products. It should also be noted that the "heavier" fraction of refined products (residual oils, asphalt, etc.) are transported by truck and rail cars to demand areas.

Four petroleum products pipelines operate in Montana. These are the Yellowstone Pipeline system (Billings to Spokane, Washington), the Farmer's Union Central Exchange (CENEX) Pipeline (Laurel to Minot, North Dakota), the Continental Oil Pipeline (Billings to Casper, Wyoming) and the Husky Oil Pipeline (Cody, Wyoming to Billings). Figure 1.5 shows the major products pipelines in the United States. Data for the size, capacity and throughput of the Montana products pipelines are given in table 1.6. Total pipeline flows of products across Montana borders are summarized for 1975 in table 1.7.

The Yellowstone Pipeline system originates in Billings; it can receive products from the three Billings area refineries and the Husky Oil Pipeline from Cody, Wyoming. Terminals on this pipeline system are located in Bozeman, Helena, Great Falls, Missoula, and Spokane. Products delivered to Great Falls by the six-inch Yellowstone Pipeline are shipped from the storage tanks at Helena, rather than directly from the main ten-inch Yellowstone Pipeline.

The percentage of total products carried by the Yellowstone Pipeline which were delivered to each of these terminals during 1975 was approximately

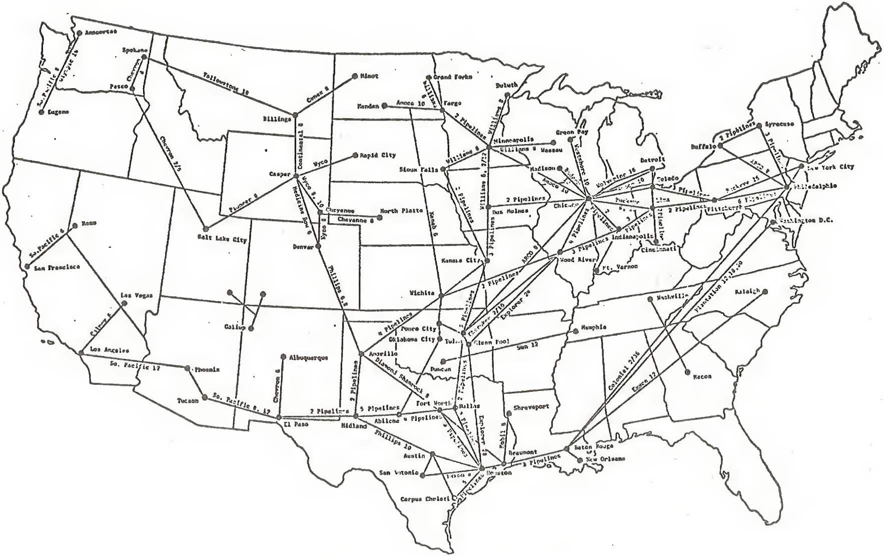

Figure 1.5. Major U.S. Products Supply Pipelines

Table 1.6

Montana Petroleum Products Pipeline Data

(In Thousand Barrels Per Calendar Day)

Pipeline	From	To	Diameter (inches)	Capacity (MBCD)	Thruput a/ (MBCD)	Source
Yellowstone	Billings	Bozeman	10	55.5	54.7	1,2,3
	Bozeman	Helena	10	55.5	49.1	1,2,3
	Helena	Great Falls	6	14.4	2.4	1,2,3
	Helena	Missoula	10	55.5	41.0	1,2,3
	Missoula	Spokane	10	55.5	32.8	1,2,3
Continental Oil	Billings	Casper, Wyo.	8	34.8	23.5	1,5
Husky Oil	Cody, Wyo.	Billings	6	15.0	4.1	1,5
Cenex	Laurel	Glendive	8	17.0 b/	14.2	1,4
	Glendive	Minot, N.D.	8	17.0	6.4	1,4

Sources: 1. Bonner and Moore Associates, Inc., *Petroleum Supply Alternatives for the Northern Tier States* (Houston, Texas, 1976) Volume III, Addendum B, Transportation.

2. Yellowstone Pipeline Company, *Annual Report to the Interstate Commerce Commission for 1975* (Ponca City, Oklahoma, 1976), Schedule 400.

3. Yellowstone Pipeline Company, *Monthly Pipeline Report to the Montana Public Service Commission,* January to December 1975 (Houston, Texas, 1975).

4. Farmer's Union Central Exchange, Inc., *Monthly Pipeline Report to the Montana Public Service Commission,* January to December, 1975 (Laurel, Montana, 1975).

5. Continental Pipeline Company, Billings, Montana, personal communications to Terry Wheeling, Montana Energy Advisory Council, Helena, Montana, November, 1976.

a/ Data is average for 1975.

b/ Work is underway which will increase the capacity to 24,000 barrels per day in 1977.

Table 1.7

Montana Pipeline Imports and Exports of

Petroleum Products During 1975

(In Million Barrels)

State (Pipeline)	Export To	Import From
Washington (Yellowstone)	12.1	
Wyoming (Continental Oil)	8.6	
North Dakota (Cenex)	2.3	
Wyoming (Husky Oil)		1.5
Net Flow	21.5	

Sources:
1. Bonner and Moore Associates, Inc., *Petroleum Supply Alternatives for the Northern Tier States* (Houston, Texas, 1976) Volume III, Addendum B, Transportation.
2. Yellowstone Pipeline Company, *Annual Report to the Interstate Commerce Commission for 1975* (Ponca City, Oklahoma, 1976), Schedule 400.
3. Yellowstone Pipeline Company, *Monthly Pipeline Report to the Montana Public Service Commission,* January to December, 1975 (Houston, Texas, 1975).
4. Farmer's Union Central Exchange, Inc., *Monthly Pipeline Report to the Montana Public Service Commission,* January to December, 1975 (Laurel, Montana, 1975).
5. Continental Pipeline Company, Billings, Montana, personal communication to Terry Wheeling, Montana Energy Advisory Council, Helena, Montana, November, 1976.

(Figures Derived.)

as follows: Bozeman 10 percent, Helena 10 percent, Great Falls 5 percent, Missoula 15 percent, and Spokane 60 percent.

The Cenex Pipeline originates at the Farmer's Union refinery in Laurel. It can receive refined products from the Continental Oil and Exxon refineries in Billings and deliver products to the Yellowstone and Continental pipelines. The other major terminals on the system are at Glendive, which received 52 percent of total deliveries in 1975, and at Minot, North Dakota, which received the remaining 48 percent of 1975 deliveries.

Work is now underway which will increase the capacity of the Cenex Pipeline from Laurel to Glendive to about 24,000 barrels per day (bpd) from the current 17,000 bpd. This project is expected to be completed by May 1977. The capacity of the Glendive to Minot section will remain at 17,000 bpd.

The Continental Oil Pipeline delivers refined products from the Billings refineries to Casper, Wyoming, where it connects with several other major petroleum products pipeline systems (see figure 1.5).

The Husky Oil Pipeline carries products from a single Husky Oil refinery in Cody, Wyoming, to the Billings area for delivery to the Yellowstone Pipeline system.

According to data from the Montana Petroleum Association, a total of 56 full-time operation and maintenance personnel are currently employed by petroleum products pipeline companies in Montana.[14]

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[14] *Ibid.*

Natural Gas Pipeline Systems

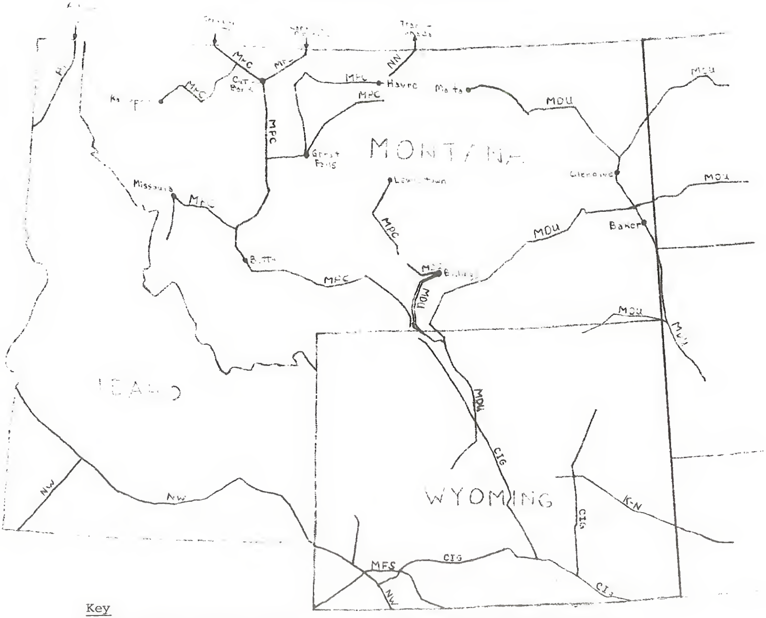
Three major natural gas pipelines systems currently operate in Montana; The Montana Power Company (MPC) system in western Montana, the Montana-Dakota Utilities (MDU) system in eastern Montana, and the Northern Natural Gas Company pipeline carrying natural gas from the Tiger Ridge fields in the northcentral part of the state to the Canadian border. In addition, several other small utilities distribute natural gas purchased from MPC, MDU, and other Montana producers. Figure 1.6 shows the major natural gas pipelines in the state, and the map included at the back of this report presents a detailed picture of natural gas lines in Montana. These three companies both import and export substantial volumes of natural gas in Montana. These flows are summarized in table 1.8 for the 1970-1975 period.

The three natural gas companies (The Montana Power Company, Montana-Dakota Utilities, and Northern Natural Gas) operate independent of each other; their pipeline systems do not interconnect, their natual gas marketing areas do not overlap, and, with one exception, they do not compete for the purchase or production of natural gas in Montana. The exception is in the Tiger Ridge area near Havre, where both MPC and Northern Natural have been actively involved in securing natural gas reserves and production.

The Montana Power Company system utilizes natural gas from Canada, and Montana to supply about 55 billion cubic feet (bcf) per year to its customers in the western two-thirds of Montana. The Canadian natural gas, which accounted for almost three-quarters of the total distributed by MPC during 1975, is received from two fields just across the border in Alberta. A subsidiary of MPC, the Canadian Montana Pipeline Company, delivers the

Figure 1.6

Major Natural Gas Pipelines in Montana



Key

MPC	Montana Power Company	CIG	Colorado Interstate Gas
MDU	Montana-Dakotas Utilities	K-N	Kansas-Nebraska Natural Gas
NN	Northern Natural Gas	MFS	Mountain Fuel Supply
PG	Pacific Gas Transmission	NW	Northwest Pipeline Co.

Table 1.8

Montana Imports and Exports of Natural Gas, 1970-1975

(In Billion Cubic Feet)

	1970	1971	1972	1973	1974	1975
Gross Imports	88.5	85.0	85.3	84.0	84.9	69.1
Gross Exports	21.2	18.9	24.1	46.6	45.0	39.1
Net Imports	67.3	66.1	61.2	37.3	39.9	30.0
Net Import (Export) From (To):						
North Dakota (MDU)	3.4	1.3	(0.3)	(1.3)	(6.5)	(7.5)
South Dakota (MDU)	(9.3)	(10.2)	(12.2)	(12.4)	(11.9)	(12.6)
Wyoming (MDU)	30.5	30.5	27.6	29.6	30.9	23.4
Canada (MPC)	42.6	44.6	48.6	50.0	47.2	42.2
Minnesota (NN)	0.0	0.0	(2.5)	(28.4)	(19.8)	(15.5)

Source: Terry Wheeling, *Montana Historical Energy Statistics*, (Helena, Montana: Montana Energy Advisory Council, 1976), Table 3.8.
Note: Details may not add to totals due to independent rounding.
MDU: Montana-Dakota Utilities.
MPC: Montana Power Company.
NN: Northern Natural Gas Company.

natural gas at the border to two MPC 16-inch pipelines. These intersect near Cut Bank and feed into the main MPC 20-inch pipeline which traverses western Montana. The Montana Power Company's major instate sources of natural gas are the fields around Cut Bank, the Tiger Ridge area near Havre, and the Bear Paw Mountains area to the south of Havre, The 10-inch pipeline from the Bear Paw area to Great Falls was completed in October of 1976, and will deliver an estimated six bcf of natural gas per year into the MPC system. The Lewiston area in central Montana is not connected to the main MPC pipeline system, but rather receives gas from local producing fields.

The Montana Power Company delivers natural gas for sale only within Montana, and therefore is not under the jurisdiction of the U.S. Federal Power Commission (FPC), except for the importation of natural gas from Canada. MPC does receive a small amount of natural gas interstate via an 8-inch pipeline from the Big Horn Basin in Wyoming to Billings. (Not shown on figure 1.6; see the attached map.) This natural gas is used only by the MPC electrical generating plant at Billings, however, and is not sold to customers so that FPC regulation is not involved. Approximately 0.4 bcf of gas was used at the power plant during 1975.[15]

Montana-Dakota Utilities (MDU) is an interstate natural gas utility, under FPC regulation, which produces and distributes gas in Wyoming, North and South Dakota, and Montana. (Natural gas production in South Dakota is negligible.) In Montana, MDU distributes approximately 20 bcf of natural gas throughout the eastern third of the state. A 12-inch pipeline delivers gas into Montana from the gas fields in northcentral Wyoming. This line

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[15] The Montana Power Company, *Annual Report to the Federal Power Commission for 1975*, p. 432.

crosses eastern Montana, deliverying to and receiving natural gas along the way. Two additional pipelines, a 10-inch and a 12-inch line, deliver natural gas from Wyoming to Billings. MDU produces substantially more natural gas in Wyoming than it sells, and consequently there is a significant flow in the MDU system from Wyoming, through Montana, to the Dakotas.

Two other areas in Montana supply significant volumes of natural gas into the MDU system. First, a pipeline from the Bowdoin field near Malta delivers natural gas to local communities and to the MDU pipelines running east and south of Glendive. Secondly, the major MDU natural gas underground storage resevoir near Baker provides an important and flexible source for the system. This resevoir allows winter peak demands in Montana and the Dakotas to be met by stored natural gas with the storage replenished during lower summer demands.

The third company operating a major natural gas pipeline in Montana, Northern Natural Gas Company, has been exporting gas produced from the Tiger Ridge area near Havre since 1972. This gas is delivered to the Trans-Canada Pipeline Company at the Saskatchewan border, and then delivered to the Northern Natural distribution system in Minnesota. The 16-inch line has a capacity of about 150 million cubic feet of gas per day, which is also the maximum export volume authorized by the FPC. This capacity is equivalent to an annual flow of about 54.75 bcf. However, as can be noted on table 1.8, the flow of gas through the Northern Natural line is substantially less than capacity. In 1975, about 15.50 bcf of gas was exported by Northern Natural, which on the average represents about 28 percent of the pipeline capacity.

II

FUTURE DEVELOPMENTS IN MONTANA'S COAL-RELATED TRANSPORTATION SYSTEMS

Most of the energy produced in Montana during the next ten to fifteen years will be exported from the state in the form of coal or energy derived from coal. This section examines the likely changes in Montana's transportation systems resulting from this projected growth. The capacities of existing rail lines and other features of the railroad system will be analyzed in detail because most coal will be shipped via unit trains. Other methods for transporting energy will also be discussed, including some--such as slurry lines and pneumatic pipelines--which currently do not exist in Montana.

Coal Production and the Capacity of Montana's Railroads

The rapid rise in coal production will lead to a corresponding growth in rail traffic. These increases will not occur throughout the state, but will be concentrated on a few lines connecting the mines with the coal consuming areas. In order to identify these routes, the export markets for Montana coal will be examined. Then, the projected increase in unit train traffic will be compared to the capacity of these lines to locate bottlenecks in other problem areas.

Export Markets for Montana Coal

A report published in 1970 predicted that the primary markets for Montana coal would be in the upper midwest.[1] Even though utilities

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[1]Montana Bureau of Mines and Geology, "Markets for Montana Coal," *Preliminary Summary Report of Strippable Low-Sulfur Coals of Southeastern Montana*, PT.2 (Butte, Montana: Montana College of Mineral Science and Technology, 1970), p. 11.

throughout the United States look to the northern great plains for low-sulfur coal, the existing rail networks place Wyoming mines in a dominant position for serving most of the central and south-central portions of the nation. The accuracy of these predictions are born out by the origin and destination statistics shown in table 2.1. These figures show utilities in Illinois, Wisconsin, and Minnesota purchased a total of about 18.1 million tons, about 82 percent of all coal mined in Montana. On the other hand, Wyoming shipped significant amounts to Colorado, Kansas, and other states generally to the south or west of those served by Montana. The fact that Illinois and several other states were large purchasers from both Montana and Wyoming suggest that there may be considerable overlap of the coal marketing areas of these two states. Notice that very little coal is exported from North Dakota. These deposits are closer to the upper midwest markets than those in Montana; but the lower energy content of lignite coal makes it relatively uneconomical to transport long distances. North Dakota coal may, however, be well-suited for mine-mouth conversion plants.

There are several projections for future coal production in the northern great plains and each presents slightly different figures.[2] Regardless of the level of coal production, marketing patterns should continue with Montana generally shipping to areas north of those served by Wyoming. Table 2.2 presents one set of projections for 1980 based on data supplied by Burlington Northern; these numbers show only coal to be transported via unit train and are not exactly comparable to those in table 2.1, which

[2] John Duffield, Thomas Power, and Terry Wheeling, "Defining the Market for Great Plains Coal," *Montana Business Quarterly* (Summer 1976), pp. 23-25. Paul E. Polzin, *Water Use and Coal Development in Eastern Montana* (Missoula, Montana: Bureau of Business and Economic Research, University of Montana, 1974), p. 98.

Table 2.1

Destination of Coal Produced in Montana, North Dakota, South Dakota, and Wyoming
1975

Destination	Montana Thousands of Tons	Montana *Percentage of Total*	Wyoming Thousands of Tons	Wyoming *Percentage of Total*	North and South Dakota Thousands of Tons	North and South Dakota *Percentage of Total*
Colorado	0	*0.0*	2,240	*9.4*	0	*0.0*
Illinois	9,466	*42.6*	2,054	*8.7*	0	*0.0*
Indiana	840	*3.8*	3,019	*12.7*	0	*0.0*
Iowa	372	*1.7*	1,918	*8.1*	0	*0.0*
Kansas	0	*0.0*	1,254	*5.3*	0	*0.0*
Michigan	1,265	*5.7*	3	*0.0*[a]	0	*0.0*
Minnesota	6,254	*28.2*	60	*0.3*	1,116	*13.3*
Missouri	0	*0.0*	1,006	*4.2*	0	*0.0*
Montana	1,206	*5.4*	0	*0.0*	0	*0.0*
Nebraska	0	*0.0*	1,361	*5.7*	0	*0.0*
North Dakota	121	*0.5*	5	*0.0*[a]	5,521	*65.6*
Ohio	0	*0.0*	927	*3.9*	0	*0.0*
South Dakota	57	*0.3*	352	*1.5*	1,778	*21.1*
Wisconsin	2,464	*11.1*	1,103	*4.7*	0	*0.0*
Wyoming	0	*0.0*	7,855	*33.1*	0	*0.0*
All other states	169	*0.8*	553	*2.3*	0	*0.0*
Total	22,214	*100.0*	23,710	*100.0*	8,415	*100.0*

Source: Terry Wheeling, *Montana Historical Energy Statistics* (Helena, Montana: Montana Energy Advisory Council, 1976), table 5.6. Percentages derived.

Note: Percentage detail may not add due to rounding.

[a]Less than 0.05 percent.

Table 2.2

Destination of Montana, Wyoming, and North Dakota Coal Transported via Unit Trains
Projected 1980

Destination	Montana		Wyoming		North Dakota	
	Thousands of Tons	*Percentage of Total*	Thousands of Tons	*Percentage of Total*	Thousands of Tons	*Percentage of Total*
Arkansas	0	*0.0*	9,250	*11.7*	0	*0.0*
Colorado	0	*0.0*	5,900	*7.5*	0	*0.0*
Illinois	10,700	*21.1*	6,000	*7.6*	0	*0.0*
Iowa	0	*0.0*	2,400	*3.0*	0	*0.0*
Kansas	0	*0.0*	6,500	*8.2*	0	*0.0*
Louisiana	0	*0.0*	3,370	*4.3*	0	*0.0*
Minnesota	14,400	*28.3*	800	*1.0*	700	*100.0*
Missouri	3,000	*5.9*	13,800	*17.5*	0	*0.0*
Montana	550	*1.1*	0	*0.0*	0	*0.0*
Nebraska	0	*0.0*	5,400	*6.8*	0	*0.0*
Oklahoma	0	*0.0*	9,600	*12.1*	0	*0.0*
Oregon	0	*0.0*	1,200	*1.5*	0	*0.0*
Texas	9,400	*18.5*	10,500	*13.3*	0	*0.0*
Wisconsin	12,700	*25.0*	1,300	*1.6*	0	*0.0*
Wyoming	0	*0.0*	3,000	*3.8*	0	*0.0*
Total	50,750	*100.0*	79,020	*100.0*	700	*100.0*

Source: Samir A. Desai and James Anderson, *Rail Transportation Requirements for Coal Movements in 1980* (Cambridge, Massachusetts: Input Output Computer Services, Inc., 1976), p. 2-25. Percentages derived.

Note: Percentage detail may not add due to rounding.

include mine-mouth electric generating plants. Minnesota, Wisconsin, and Illinois are projected to remain Montana's major coal customers while Wyoming will continue to dominate the southern market, as shown by the large purchases by utilities in Arkansas, Oklahoma, and Kansas. There are some exceptions; for example, about 9.4 million tons are projected to travel from Montana to Texas. This coal will originate at the Decker Coal Company mine just north of the state border where the only rail connections are south through Wyoming. A utility may be forced to a more distant supplier if closer sources are unable to meet specific needs.

The projected sales to the upper midwest suggest that the routes of unit trains through Montana discussed earlier will probably continue in the future. Shipments originating on the Hysham (Westmoreland mine) or Nichols (Western Energy Company or Peabody Coal Company mine) spurs and destined for the upper midwest would travel east through Montana along the old Northern Pacific mainline and enter North Dakota near Beach.[3] Coal from the Decker area (the Decker Coal Company mine and the proposed Shell mine) would initially travel south into Wyoming. The portion destined for the northern midwest--Michigan, for example--may swing west through Sheridan and then north to Huntley, the remaining tonnage would continue southeast through Wyoming to markets further south--for example, Texas.

Despite the fact that most coal has been shipped to the east, Montana has been mentioned as an energy supplier for the northwest. A consortium of west coast utilities are scheduled to receive a significant portion of

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[3] Trains for northern Minnesota and Wisconsin are projected to transfer to the highline (formerly the Great Northern Railroad) in eastern North Dakota. See Samir A. Desai and James Anderson, *Rail Transportation Requirements for Coal Movements in 1980* (Cambridge, Massachusetts: Input Output Computer Service, 1976), pp. 2-27.

the electricity generated at Colstrip III and IV. There is also a possibility that northern great plains coal will also be transported westward to fire new electric generating plants in Washington or Oregon.

The northwest has relied almost exclusively on hydro generation to supply electricity. The situation is changing, however, because most of the feasible sites have already been developed. The utilities will have to use either nuclear or coal-fired generation to meet projected future increases in electrical demand. Despite the defeat in the last election of the nuclear referendum in Washington State, nuclear power plants have been severely critized in recent years and face an uncertain future. This leaves only coal as a secure source of electric power in the northwest, and the northern great plains represents an available supply.[4]

The northwest utilities anticipate that they will build generating plants in their service areas, probably in Washington or Oregon. In other words, they are not now planning additional mine-mouth generation plants at Colstrip, connected to the load centers with long distance transmission lines. This should not be misinterpreted, these utilities have not been intimidated by Montana. They sincerely believe they are justified and could, if they choose, successfully present their case before Montana authorities. In their opinion, the administrative processes are unnecessarily long, cumbersome, and expensive in Montana and the same decision could be obtained quicker and at less cost in Washington or Oregon.

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[4]There are coal deposits in Washington, Oregon, and Idaho; but they are generally very small and the economic feasibility of mining this coal is presently uncertain. The major exception are the strippable deposits in western Washington, which are already committed to the coal-fired plants at Centralia. There is the possibility that Alaskan coal may be barged up the Columbia River to electric generation sites. There is currently insufficient information to evaluate the feasibility of this proposal.

The impact on Montana's transportation systems of new coal-fired generating plants in the northwest will depend on their exact location.[5] If they are built in central Washington or northern Oregon along the Columbia River--sites often mentioned because of the availability of water for cooling--the coal may be shipped from either the Powder River Basin in Montana and northern Wyoming or from the coalfields in southwestern Wyoming. The Portland General Electric Company is building a 500 MW generating plant near Boardman, Oregon, which is scheduled to begin operation in 1980. A coal contract for about 1.2 million tons per year has been signed with a mine near Gillette, Wyoming--this is probably the coal projected for Oregon in 1980 shown in table 2.2. The exact route has not yet been determined; it is likely to be through Montana to Spokane, Washington, and then south to Oregon. Additional plants may, however, receive coal from southwestern Wyoming; it is about 800-900 rail miles from the coalfields near Rock Springs, Wyoming, through Idaho to north-central Oregon, about the same as from Billings through Spokane. But the southern route may lead to lower transportation costs because it is downhill from a relatively low pass in southwestern Wyoming. In short, the source and routing of coal for generating facilities in southcentral Washington or northcentral Oregon cannot be predicted; there is a distinct chance that it will be mined in southwestern Wyoming and there will be no direct impact on Montana.

There are alternative locations in eastern Washington or northern Idaho for new generating plants serving the northwest. These plants would

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[5]The following analysis was based on interviews and conversations with officials at the Washington Water Power Company of Spokane, Washington, and the Portland General Electric Company in Portland, Oregon.

be intended primarily for the Washington Water Power Company service area and there is a much greater probability that they would use Powder River Basin coal shipped via unit train through Montana.

There are two rail routes from the Powder River Basin coalfields west through Montana. The first is the old Northern Pacific mainline through Billings, Helena, and Missoula while the second swings north at Mossmain, Montana, and proceeds through Great Falls and Shelby and then west along the former Great Northern highline. The northern route is longer by about 100 miles, but may be preferable because it has a more gentle slope over the continental divide. A grade of 2.2 percent on a portion of the former Northern Pacific line near Helena may limit coal unit trains to a total weight of 5,000 tons, or about 50 hopper cars with capacities of 100 tons each.[6] This represents a 50 percent reduction as compared to a normal unit train of one hundred hopper cars. (The alternate Burlington Northern route through Butte is not considered suitable for large-volume high-speed traffic.) The 10,000 ton unit train will continue to be the norm throughout this study, however, even though it may not be feasible on this section of track.

The potential northwest market for low sulfur coal may be put in perspective by keeping in mind that during 1974 the combined population of Washington, Oregon, and Idaho was about 6.4 million persons.[7] This compares to approximately 11.1 million persons in Illinois, 9.1 million persons in Michigan, and 4.6 million persons in Wisconsin. Energy consumption depends on more than just the number of persons. Nevertheless,

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[6]Burlington Northern (Billings, Montana, 1976).

[7]U.S. Bureau of the Census, *Statistical Abstract of the United States: 1975* (Washington, D.C.: U.S. Government Printing Office, 1975), p. 13.

these population figures suggest that, everything else being equal, future shipments of coal from the northern great plains to the northwest will be only a fraction of the tonnage destined for the midwest.

Significant shipments of coal to Washington or Oregon are not likely to begin soon. The 1.2 million tons per year for Boardman are scheduled to start in 1979. There are currently no concrete proposals for additional coal-fired generating capacity in the northwest. Given the eight to ten years required for the approval and construction of new plants, it may be 1985 or later before coal shipments to the northwest grow beyond 1.2 million tons per year.

Capacity of Montana's Railroads

The capacity of a rail line is, everything else being equal, primarily determined by the track configuration and signaling systems.[8] The basic configurations include single track, single track with sidings, alternating single and double tracks, and double tracks. Sidings on a single track permit the passing of trains traveling in the same or opposite direction. The closer the sidings the greater the number of trains which can be operated on a given track. The length of the trains passing each other is determined by the length of the siding.

The signal system determines the spacing of trains on a track; that is, how close they can be run to each other. Centralized Track Control (CTC) is the most advanced, including a central station with direct radio contact to each train and remote control of the siding switches. Automated Block Signals (ABS), also a widely used signal system on Montana mainlines,

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[8] Samir A. Desai and James Anderson, *Rail Transportation Requirements for Coal Movement in 1980*, p. 2-30 to 2-33.

utilizes telegraph operators to establish "meets" between trains on a single track.[9] This manual system increases the time required for each meet over that associated with the remote control of switches and signals, and reduces the theoretical capacity of a line from the CTC figures.

Table 2.3 presents the estimated capacity in terms of coal unit trains per day of alternative track configurations equipped with Centralized Track Control. These figures show that significant increases in rail traffic can be obtained by building sidings at appropriate distances on a single track line. The potential maximum capacity of a right-of-way equipped with double track and centralized track control is about 128 trains per day. If such a line were entirely devoted to coal unit trains and allowing for the empty return trips, it could transport approximately 230-235 million tons per year.

Keeping the coal markets in mind, the routes of unit trains through Montana are easy to identify. The most probable are all on Burlington Northern rights-of-way. Even though the Milwaukee Road (The Chicago, Milwaukee, St. Paul and Pacific Railroad) crosses Montana from east to west, operating and planned mines are all located on Burlington Northern spurs and unit trains are likely to remain on these tracks while in the state. The most likely coal route consists of the former Northern Pacific mainline east from Nichols to the North Dakota border; this will be the major route for transporting coal across Montana to the upper midwest. A second route is from Sheridan to Huntley, allowing coal from Wyoming or the Decker area of Montana to swing north and then east toward the upper midwest. If necessary, this line could also carry coal south from Montana.

[9] *Ibid.*, Appendix B.

Table 2.3

Estimated Capacity of Alternative Track Configurations with Centralized Traffic Control (CTC) Signal System

Configuration of Rail Line	Average Number of Coal Unit Trains per Day[a]
Single track	
Two and one-half mile sidings, eleven miles apart	20-25
Two and one-half mile sidings, seven miles apart	30-35
Five mile sidings, seven miles apart	40-45
Alternating single/double track	
Ten miles double and thirty miles single track, with two and one-half mile sidings	50-55
Ten miles double and 10 miles single track	60-70
Double track	70-125

Source: Samir A. Desai and James Anderson, *Rail Transportation Requirements for Coal Movements in 1980* (Cambridge, Massachusetts: Input Output Computer Services, Inc., 1976), p. 2-32.

[a]Assumes a capacity of 10,000 tons per train.

The final route is west from Huntley to the northwest markets; as discussed earlier, this could be via Helena and Missoula or turn north at Mossmain and proceed through Great Falls and Shelby.

Burlington Northern's coal traffic projections to 1980 for each track segment are presented in table 2.4. These figures show the greatest coal traffic will be, as expected, toward the upper midwest along the old Northern Pacific mainline; by 1980, an average of about 29 coal trains per day (including empty trains on their return trip) are projected to travel between Nichols and the North Dakota border. There may be an additional ten trains per day carrying other commodities. Therefore, this track segment is projected to average about forty trains per day. The remaining track segments are projected to experience significantly less growth in coal traffic.

Current track conditions and signal systems along selected portions of Burlington Northern's Montana routes are presented in table 2.5. Centralized Track Control (CTC) is operational on almost the entire former Great Northern highline and most of the former Northern Pacific's mainline west of Mossmain. East of Mossmain, CTC is operational along certain portions with the remaining segments either double tracked or having Automated Block Signals.

The track segment east of Forsyth, which is projected to experience the greatest increase in coal traffic, presently averages one mile-long siding approximately every seven miles and has Automated Block Signals. Its current capacity has not been determined, but a roughly similar Burlington Northern line in Nebraska is rated at 15 to 20 trains per day.[10]

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[10] *Ibid.*, p. 2-34. The 1976 flood along the Missouri River in North Dakota closed the highline and the traffic was rerouted along this segment. During this period, up to thirty trains per day traveled the lowline route. See *The Bismark Tribune* (May 3, 1976), p. 1.

Table 2.4

Coal Traffic by Track Segment, in 1975 and Projected 1978 and 1980

Track Segment	----- Millions of Tons -----			Average Number of Coal Unit Train per Day[a]		
	1975	Projected 1978	Projected 1980	1975	Projected 1978	Projected 1980
Nichols, Montana to Casselton, North Dakota	24.0	43.5	53.7	13	24	29
Huntley, Montana to Nichols, Montana	11.3	22.7	30.3	6	12	17
Sheridan, Wyoming to Huntley, Montana	2.6	11.6	18.9	1	6	10
Huntley, Montana to Spokane, Washington	0.0	0.0	1.3	0	0	1

Source: Samir A. Desai and James Anderson, *Rail Transportation Requirements for Coal Movement in 1980* (Cambridge, Massachusetts: Input Output Computer Services, Inc., 1976), p. 2-28.

[a]Assumes a capacity of 10,000 tons per train; also, includes an empty return trip.

Table 2.5

Signal System and Sidings on Selected Montana Track Segments
1976

Track Segment	Length of Segment (Miles)	Type of Signal[a]	Number of Sidings	Average Length of Sidings (In Feet)	Average Distance between Sidings (In Miles)
Beach, North Dakota to Glendive, Montana	41.1	ABS	6	6,964	6.8
Glendive, Montana to Forsyth, Montana	123.7	ABS	19	6,181	6.5
Forsyth, Montana to Hysham, Montana	27.4	CTC	3	6,379	9.1
Hysham, Montana to Huntley, Montana	61.8	ABS-CTC	11	6,761	5.6
Huntley, Montana to Mossmain, Montana	24.4	ABS[b]-CTC	3	8,691	8.1
Gillette, Wyoming to Huntley, Montana	232.1	ABS	24	5.657	9.6
Mossmain, Montana to Shelby, Montana	320.6	ABS	20	5.380	16.0
Shelby, Montana to Yakt, Montana	276.7	ABS[b]-CTC	27	9,154	10.3
Mossmain, Montana to Noxon, Montana	489.1	ABS-CTC	59	7,537	8.3

Source: Burlington Northern, Inc., *Time Table 17, Billings Region* (Billings, Montana, 1976).

Note: Industrial sidings are excluded.

[a]ABS denotes Automated Block Signal: CTC denotes Centralized Traffic Control.

[b]Double track.

Comparing the present signaling system and track configuration to those in table 2.3 suggests that the addition of Centralized Track Control and the lengthening of certain sidings could increase the capacity of this segment to 40-45 trains per day, approximately equal to the projected traffic during 1980.

The routes from the Powder River Basin toward the northwest will probably require less upgrading; both the highline and the lowline have Centralized Track Control along their western portions. The segment from Mossmain to Shelby, which would be used if the highline route is chosen, may require investments in additional sidings and/or lengthening of existing sidings if there is significant traffic growth.

Burlington Northern's specific plans for upgrading track segments in Montana are not known. They are aware of the potential problems (the traffic projections are theirs) and it is reasonable to assume they will undertake the necessary improvements in order to accommodate the increased number of coal trains. The plans for a track segment in Nebraska are known and may provide a rough idea of what lies ahead in Montana. Coal traffic along the Burlington Northern line between Alliance and Lincoln is projected to increase from 10 to 70 trains per day (including empties) between 1975 and 1980.[11] Currently, this segment has a single track with sidings and has an estimated capacity of 15-20 trains per day. Burlington Northern plans to invest about $30 million on this segment. When completed, there will be Centralized Track Control with double tracks and alternating single and double tracks. The entire project is scheduled to be completed by 1980; suggesting that Burlington Northern believes that it can quickly implement significant increases in capacity.

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[11] Samir A. Desai and James Anderson, *Rail Transportation Requirements for Coal Movement in 1980*, pp. 2-34.

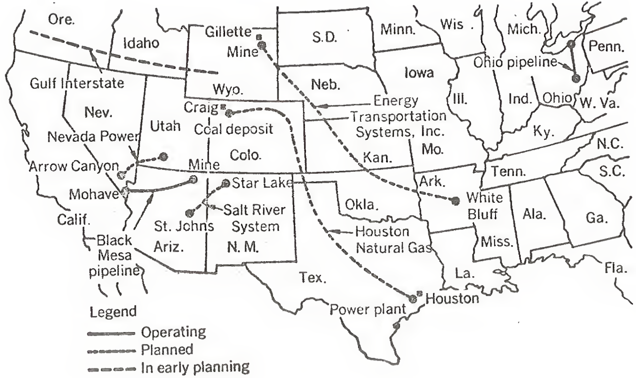
Beyond 1980, the picture remains cloudy. Earlier it was noted that the theoretical capacity of a double tracked line with Centralized Track Control is about 220 million tons of coal per year. If the track east of Forsyth were equipped in this manner, it could carry the entire projected annual output of Montana coal for the next thirty years with sufficient leeway to allow significant amounts of Wyoming coal to be routed through the state toward the upper midwest. The eastern portion of the highline is projected to carry very little coal--only lignite is located along this segment and it is unlikely that significant amounts of this low BTU coal will be exported from Montana--and most non-coal traffic could be diverted to this route. The major problem facing the Burlington Northern may be their ability to raise sufficient capital to undertake the necessary investments in upgrading rights-of-way and increased rolling stock. To some extent, the financial problems may be lessened by third party ownership of unit trains. The position of the coal-hauling railroads in the financial markets may be determined by the outcome of the current controversies concerning slurry pipelines, which will be discussed next.

Coal Slurry Pipelines

Slurry pipelines have been the subject of controversy in Montana and throughout the northern great plains. The immediate cause of concern has been a proposal, shown in figure 2.1 to build a pipeline carrying low-sulfur coal from Gillette, Wyoming, to White Bluff, Arkansas. Even though not directly affecting Montana, concern has been expressed that, if built, this pipeline would originate only a few miles from the Montana border and would be relatively simple to extend into the state. These fears may not materialize because there appears to be few incentives to expand this

Figure 2.1

Coal Slurry Pipelines



Source: John M. Haneke, Vice President, Energy Transportation Systems, Inc., Prepared Statement befor the U.S. Senate Committee on Interior and Insular Affairs, June 11, 1974.

Note: Ohio pipeline abandoned in 1963.

pipeline into Montana. There are sufficient coal reserves in Wyoming to supply such a facility for hundreds of years. In addition, crossing the border would invite potential review, approval, and regulation by Montana authorities. This prospect may be unappealing to the project sponsors because the proposed route already crosses portions of Wyoming, Nebraska, Kansas, Oklahoma, and Arkansas, and may be subject to the regulations of the appropriate state agencies. Another slurry from Wyoming or Montana to Oregon has been proposed.[12] Little interest has been shown in this project and it may have been shelved. Nevertheless, coal slurry lines are an often-mentioned alternative for exporting coal from Montana and this section presents some of the important features of this method for transporting energy.

Characteristics of Coal Slurry Pipelines

Slurry pipelines carry solids suspended in a liquid. The solids can be almost anything--coal, copper concentrate, oil shale tailings, etc.--and the liquid can be water, hydrocarbons, or liquids. Slurry pipelines transporting coal suspended in water are by far the most likely for Montana and the discussion will be limited to this alternative.

Coal is crushed and ground to a consistency similar to sugar. The resulting slurry is pumped through an underground pipeline at about three and one-half miles per hour.[13] Pumping stations are situated at 50 to 100

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[12] Northwest Pipeline Corporation and Gulf Interstate Engineering Company, *Preliminary Engineering and Economic Evaluation of a Proposed Pacific Northwest Coal Slurry Pipeline System* (Salt Lake City, Utah, 1975).

[13] Michael J. Murphy, Susanne Maeder, and James I. McIntire, *Northern Great Plains Coal: Conflicts and Options in Decision Making* (Minneapolis, Minnesota: Upper Midwest Council, 1976), p. 6-14.

mile intervals.[14] At its destination, the coal is removed from the water with a filter; coal does not absorb much water and the two may be easily separated. After drying, the coal may fire an electrical generating plant or other facility. The water may be discarded or saved for future use, such as recycling it into the cooling mechanism of the plant.

Coal slurries are a well-proven form of transportation and are feasible using current technologies. Two slurries have been built in the United States. The Black Mesa Pipeline transports about 4.8 million tons of coal per year over a 273 mile route between Kayenta, Arizona, and the Mohave Power Plant in Nevada.[15] A 108 mile coal slurry was constructed in 1957 from Cadiz, Ohio, to an electric generating plant near Cleveland, Ohio. This line operated successfully for six years, carrying about 1.3 million tons per year, until reduced railroad freight rates made it uneconomical.

Slurry pipelines are very capital intensive. Before the first ton of coal is shipped, there have to be expenditures for the coal preparation facility at the mine, the pipeline and associated pumping systems, drying facilities at the destination, and right-of-way acquisition. For example, the total capital investment for the proposed 1,040 mile Wyoming-Arkansas line has been estimated to be between $750 million (1975 dollars) and $1,034 million (1975 dollars), an average of $721,000 (1975 dollars) to $1 million (1975 dollars) per mile.[16] Once operational, however, slurry

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[14]Federation of Rocky Mountain States, "A Comparison of Unit Trains and Slurry Pipeline Transportation of Coal," Mimeographed draft (Denver, Colorado, 1976), p. 2.

[15]*Ibid.*, p. 4.

[16]Michael Murphy, Susanne Maeder, and James McIntire, *Northern Great Plains Coal: Conflicts and Options in Decision Making*, p. 6-16. S.L. Soo and L. Ballard, "Costs of Transportation of Coal: Rail vs. Slurry Pipeline," Mimeographed (Urbana, Illinois: Department of Mechanical and Industrial Engineering, University of Illinois, 1975), p. 25.

pipelines require small operational expenditures, with labor and power (for the pumps) being the major items. The proposed Wyoming-Arkansas slurry may employ approximately 245 workers; about 30 to 40 located at both the origin and the destination with the remainder scattered along the line.[17] The average earnings of these workers would be about $18,750 (1975 dollars) per year. In Montana, these positions would compare favorably with those of the railroads and rank among the highest-paying jobs in the state.

In order to be economical, slurry pipelines must be operated at or very near their designed capacity. The Ohio and Arizona pipelines were built to transport about 1.5 and 5 million tons per year, respectively. The capacity of proposed new slurry pipelines range from 9.1 million to 25 million tons per year.[18] Doubling the capacity of an existing slurry line would require a fourfold increase in pumping power.[19] In short, slurry pipelines are not well-suited for situations involving significant fluctuations in demand; they perform best in transporting a given quantity of coal between two points year after year.

The water requirements of slurry pipelines are a sensitive issue in the semi-arid northern great plains. A 25 million ton per year slurry similar to the Wyoming-Arkansas proposal, would use about 15,000 acre-feet

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[17] S.L. Soo and L. Ballard, "Costs of Transportation of Coal: Rail vs. Slurry Pipeline," p. 25.

[18] T.C. Campbell and Sidney Katell, *Long-Distance Coal Transport: Unit Trains or Slurry Pipelines*, pp. 24-25. S.L. Soo and L. Ballard, "Cost of Transportation of Coal: Rail vs. Slurry Pipeline," p. 25.

[19] S.L. Soo and L. Ballard, "Cost of Transportation of Coal: Rail vs. Slurry Pipeline," p. 25.

a year; smaller lines would consume proportionately less water.[20] In comparison, a 750 MW coal-fired electrical generating facility, similar to proposed Colstrip Units III or IV, requires about 12,000-14,000 acre-feet per year and a gasification plant would use approximately 10,000 acre-feet per year.[21] A recently completed study concluded there is sufficient water in eastern Montana for a moderate level of coal-related development.[22] Therefore, a small number of coal slurries originating in Montana would not by themselves place a significant burden on the region's water supply.

It has been suggested that the water used in slurries may be recycled at the destination and pumped through the cooling system of the electric generating plant. This proposal may be intended more to mollify westerners, who hate to see a drop of wasted water, than based on objective cost-minimizing analysis. Arkansas and other proposed pipeline terminals are not usually considered to be water-short areas. Even under best conditions, the slurry water may require some treatment, which may raise its cost relative to the abundant local water sources. It has also been proposed that the slurry water be piped back to the starting point and reused. This would increase costs about 40 percent and may make the slurry uneconomical.[23] In short, it is doubtful that a significant effort is justified to conserve the last drop of water.

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[20] Federation of Rocky Mountain States, "A Comparison of Unit Trains and Slurry Transportation of Coal," p. 8.

[21] Paul E. Polzin, *Water Use and Coal Development in Eastern Montana*, p. 91.

[22] *Ibid.*, pp. 193-198.

[23] S.L. Soo and L. Ballard, "Cost of Transportation of Coal: Rail vs. Slurry Pipeline," p. 22.

The local economic impact of a coal slurry pipeline may be divided into two phases. The construction of a typical slurry may require about two years and employ about 1,200 workers.[24] The workers will probably be scattered along the route, with several segments of the line being built simultaneously. Consequently, significant impacts may occur only during the short period when the construction workers are in a specific area. Once in operation, the permanent employees will be situated at the origin and destination of the pipeline and at the pump stations. Based on the estimate of 245 permanent workers for the proposed Wyoming-Arkansas pipeline, the number of new jobs directly associated with slurries may not have a significant regionwide impact. But, since the pipeline route will transverse rural areas, the workers stationed at isolated pump stations may represent sizable increases for small communities. With average earnings of about $18,750 (1975 dollars per year) and the likelihood they will be full-time year-round positions, coal slurry employment may be a welcome addition to the local economic base. There are currently no estimates concerning the degree to which these jobs could be filled by current residents.

Coal slurry pipelines in Montana will pay property taxes to the counties, school districts, and other jurisdictions in which they are situated. According to current practices, the facilities within the state would be assessed partially by local authorities and partially by the Montana Department of Revenue. The centrally assessed values will be allocated back to the appropriate jurisdiction.[25] Both components (locally and centrally assessed) would be subject to the local millage levied

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[24] Federation of Rocky Mountain States, "A Comparison of Unit Train and Slurry Pipeline Transportation of Coal," p. 18.

[25] *Revised Codes of Montana*, 1947 § 84-301 (L. 1975).

against property. Therefore, the tax revenues accruing to a county, school district, or other jurisdiction will depend on the amount and assessed value of pipe or other facilities located within its borders.

In summary, coal slurry pipelines appear to be a technologically feasible method for transporting coal. They are characterized by a large initial investment in capital and equipment with correspondingly low operational costs. Slurries are best suited for transporting large volumes of coal between two distant points. They use large quantities of water, which will be lost to the supplying region, but these volumes will not by themselves dewater the northern great plains. Only a moderate number of new jobs will be created along the route of the pipeline, but they will be high-paying and stable positions.

Opposition to Coal Slurry Pipelines

In addition to the concerns about water consumption, coal slurries have been attacked on environmental grounds and by the railroads. Environmentalists have criticized coal slurry pipelines on the basis of their land-use characteristics and the potential for ecological damage. When measured in terms of area, slurry pipelines require very little land. They are buried two and one-half to three feet underground and the surface above them may be reclaimed and returned to its former use. The only permanent land use is for processing facilities at each end of the pipeline and pumping stations along the route. A one thousand mile 38-inch diameter slurry pipeline would disturb 12,500 acres, but only 770 surface acres would be permanently removed from other uses by structures such as pumping stations, coal preparation facilities, and coal drying plants.[26] But,

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[26]Federation of Rocky Mountain States, "A Comparison of Unit Train and Slurry Pipeline Transportation of Coal," p. 10.

slurry pipelines must be built with gradual slopes to reduce friction and wear on the pipeline.[27] Consequently, a straightline route may not be feasible and significant earth fill may be necessary when crossing areas similar to the rugged and rolling terrain in eastern Montana and Wyoming. This may explain the lack of interest in the proposed slurry from Montana or Wyoming to Oregon; such a pipeline would cross the continental divide and require many changes in elevation.

No matter how carefully they are constructed and maintained, pipelines can leak, there may be a power failure, or a breakdown at a pumping station. If such a disaster occurs, water is introduced into the line at an upstream station and the slurry is dumped ahead of the emergency.[28] The slurry cannot be stopped because the coal may settle and plug the pipe. In order to minimize serious ecological damage, dump ponds have to be situated along the pipeline route. Based on the proposed Wyoming-Arkansas slurry, the required capacity of each pond is about 3.6 million cubic feet, an area approximately equal to seven football fields filled to a depth of 10 feet.[29]

The opposition of the railroads appears to be based on the belief that slurry pipelines will "skim the cream" off the coal market--the long term and high-volume point-to-point shipments--and leave them with the relatively unprofitable hauls. Further, they reason, coal slurries may jeopardize

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[27]Michael J. Murphy, Susanne Maeder, and James I. McIntire, *Northern Great Plains Coal: Conflicts and Options in Decision Making*, p. 6-38.

[28]S.L. Soo and L. Ballard, "Cost of Transportation of Coal: Rail vs. Slurry Pipeline," p. 29.

[29]Burlington Northern, Prepared Supplemental Statement, Before the U.S. Senate, Committee of Public Works in Conjunction with the Committee on Interior and Insular Affairs, Hearings on Greater Coal Utilization, June 1975, p. 2.

the ability of railroads to raise the capital required for the additional equipment, improved rights-of-way, and other investments needed to transport increasing quantities of coal.

The sponsors' of the Wyoming-Arkansas slurry counter that there is room for both; its 25 million tons per year would represent only a small portion of the projected 125 to 175 million tons per year to be exported from the northern great plains by the middle of the 1980s.[30] Further, they question whether railroads can expand sufficiently to meet the projected demands for coal transportation.[31]

Even though the wrath of the railroads is directed toward the Wyoming-Arkansas slurry, the most advanced of the coal pipeline proposals, it appears they are more concerned with preventing a precedent than with blocking this specific project. If one slurry is built and is successful, more are likely to follow if they can obtain water and the necessary government approvals. Therefore, the railroads are not afraid of losing just 25 million tons of coal per year, but a much larger portion of the potential increase in coal traffic.

Coal Slurries vs. Unit Trains

A number of studies have been completed which compare the costs of transporting coal via slurry or unit trains.[32] The results are inconclusive;

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[30] Federation of Rocky Mountain States, "A Comparison of Unit Train and Slurry Pipeline Transportation of Coal," p. 22.

[31] Michael J. Murphy, Susanne Maeder, and James I. McIntire, *Northern Great Plains Coal: Conflicts and Options in Decision Making*, p. 6-26.

[32] Michael J. Murphy, Susanne Maeder, and James I. McIntire, *Northern Great Plains Coal: Conflicts and Opinions in Decision Making*, p. 6-18. T.C. Cambell and Sidney Katell, *Long Distance Coal Transport: Unit Trains or Slurry Pipelines*, p. 24. S.L. Soo and L. Ballard, "Costs of Transportation of Coal: Rail vs. Slurry Pipelines," pp. 23-31.

slurries produced lower costs in one study, railroads were less expensive in another, while a third found a broad overlap between them. Some of the differences may be the result of dissimilar assumptions or methods for computing costs; for example, the average cost per ton-mile, the cents per one trillion BTU per day movement for a distance of 1,000 miles over a "typical" terrain, and the cost per kilowatt hour of the electricity generated from the coal, were all used in determining the least expensive form of transportation. The fact that neither slurries nor unit trains is obviously superior in terms of costs does not rule out the possibility that for specific cases one may be preferable to the other, though the margin may be small.

The low per-unit transportation costs of slurries may not be realized in practice. Even though coal pipelines with capacities as little as 9.1 million tons per year may be feasible under certain conditions, volumes in the neighborhood of 15-25 million tons per year may be required to achieve competitive per unit costs. The Wyoming-Arkansas proposal envisioned a slurry supplying a single electric generating complex with four 800 megawatt units. The Arkansas Public Service Commission denied permits for two of the proposed units on the basis that they would create an adverse impact on the environment.[33] As a result, the entire throughput of this proposed slurry would not be consumed at a single site.

The Arkansas decision may not be an isolated case. Coal-fired generating complexes having sufficient capacity to consume the entire throughput of a large slurry may be found to create unacceptable environmental problems

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[33] Federation of Rocky Mountain States, "A Comparison of Unit Train and Slurry Pipeline Transportation of Coal," p. 24.

elsewhere in the nation. Small slurries, unit trains, or conveyors could distribute coal to dispersed electrical generating sites from the trunk slurry line, but this could increase total costs and may tip the scales in favor of alternative transportation modes.

Prior studies comparing unit trains and slurries have emphasized transportation costs. Since these costs are usually born by the purchasers of the coal and then transferred to the consumers of the energy, they have only limited relevance to Montana as an energy supplier.

Each slurry pipeline or unit train proposal must be evaluated separately in order to determine the number of new Montana jobs which will be created. The location of railroad crew changes and slurry pump stations are among the determinants of the number of positions which will actually occur in the state. Further, valid comparisons between unit trains and slurries require that analogous situations be evaluated; it would not be appropriate to compare unit trains originating at Colstrip and traveling the 165 miles east to North Dakota with a slurry pipeline starting at Decker and leaving Montana twenty miles to the south. A rough idea of the magnitudes involved may be derived from a study which concluded that transporting 25 million tons per year from Montana to Minnesota via unit trains would lead to a total of about 750 new railroad jobs or a total of approximately 250 slurry positions.[34] The distribution of the new positions will be roughly proportional to distance

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[34]Michael J. Murphy, Susanne Maeder, and James I. McIntire, *Northern Great Plains Coal Conflicts and Opinions in Decision Making*, p. 6-23. Although the exact estimates vary between sources, railroads appear to create about three times the number of jobs as a comparable slurry pipelines. See Federation of Rocky Mountain States, "Comparison of Unit Train and Slurry Transportation of Coal," p. 16. S.L. Soo and L. Ballard, "Costs of Transportation: Rail vs. Slurry Pipeline," p. 32.

and only a small portion are likely to occur in Montana. For example, only about 185 of the 1,250 rail miles between Colstrip and Wautegan, Illinois, are in Montana (see table 1.1). Even allowing a significant margin for error, it appears safe to conclude unit trains will lead to a greater increase than slurry pipelines in local employment.

Coal slurry pipelines and unit trains will provide jobs paying about $18,000 to $20,000 per year and will not be subject to severe seasonal or cyclical swings. In short, both will provide high-quality employment opportunities for Montanans.

Conveyors and Pneumatic Pipelines

Conveyor belts are a traditional and well-proven transport method while pneumatic pipelines are on the technological frontiers of transportation research. Both methods may be best suited for shipping large volumes over relatively short distances, about twenty miles or less. Conveyors and pneumatic pipelines may be used to gather coal from a number of scattered small mines to a central facility for loading onto unit trains or a slurry pipeline.[35] At the destination, similar installations could dispense the coal from the unloading or drying facilities to scattered conversion plants.

Conveyor systems may be feasible for distances up to approximately 15 miles.[36] As shown by the following figures, their costs compare favorably to trucks used under the same conditions:

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[35] S.L. Soo and L. Ballard, "Cost of Transportation of Coal: Rail vs. Slurry Pipeline," p. 20.

[36] T.C. Campbell and Sidney Katell, *Long Distance Coal Transport: Unit Trains or Slurry Pipelines*, p. 24.

Carrier	Transport Costs, Cents Per Ton-Mile	Restrictions
Truck	5.0 to 8.0	One-way haul, empty return
Conveyor belt	2.0 to 6.0	Less than 15 miles

The major application of conveyor belts has been supplying electric generating plants from nearby coal mines, such as at Colstrip.

Pneumatic pipelines currently exist only in theoretical engineering monographs: there are no operational systems nor are there concrete proposals for construction. Nevertheless, some engineering experts believe they have the potential to be an effective method for transporting coal. Pneumatic systems covering distances less than 20 miles have received the most attention in the past.[37] Current research suggests, however, that pneumatic transport of coal may be feasible up to about 100 miles.[38] The advocates of pneumatic pipelines claim that this transportation system may be superior in certain applications because they require less expensive loading and unloading equipment than unit trains and, since the coal is shipped dry, there is no need to purchase water or build drying facilities at the destination.[39]

Montana's large coal mines are capable of supplying millions of tons from one source. There would be little advantage to constructing a feeder system from several mines to a common collecting point. The only likely

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[37] S.L. Soo and L. Ballard, "Cost of Transportation of Coal: Rail vs. Slurry Pipelines," p. 37.

[38] S.L. Soo, J.A. Ferguson, and S.C. Pan, "Feasibility of Pneumatic Pipeline Transport of Coal," mimeographed (Urbana, Illinois: Department of Mechanical and Industrial Engineering, University of Illinois, 1975), pp. 2-4.

[39] *Ibid.*, pp. 5-6.

applications of conveyor or pneumatic systems in Montana would be for conversion facilities where the coal is transported from the mine to the processing site.

Water Transportation of Coal

Significant amounts of Montana coal arrive at their destination on barges or other forms of water transportation. About seven million tons per year is scheduled to be loaded onto unit trains at the Decker Coal Company mine and be transported to Superior, Wisconsin, where it is transferred to lake freighters for the trip to Detroit, Michigan.[40] An additional five million tons per year is transported via unit train from Decker to Havanna, Illinois, and then loaded onto barges and towed to three Commonwealth Edison Company electric generating plants located on the Illinois River.[41]

Montana is not served by navigable waterways.[42] Coal must be transported from the mine to a port and then transferred to barges. Since loading and unloading represent a large share of total transportation costs, the additional handling of the coal may eliminate the potential economies of water transport, which is usually considered the least expensive method

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[40] William Tomlinson, "Northern Great Plains Coal Contract Data," Montana University Coal Demand Study Working Paper Number 4, Mimeographed (Missoula, Montana, University of Montana, 1975), p. 4.

[41] Samir A. Desai and James Anderson, *Rail Transportation Requirements for Coal Movement in 1980* (Cambridge, Massachusetts: Input Output Computer Services, Inc., 1976), pp. 2.51-2.55.

[42] The U.S. Army Corps of Engineers considers Sioux City, Iowa, as the head of navigation for the Missouri River. U.S. Army Corps of Engineers, Office of Policy, "Navigable Waterways of the United States Constructed and Maintained by the U.S. Army Corps of Engineers," Mimeographed, p. 5.

for shipping coal and other bulky commodities. Conceptually, water transportation of Montana coal may be economical if it is shipped sufficient distances on barges so that the lower costs per ton-mile compensate for the additional loading and unloading charges.

Low costs may not explain the use of water transportation to destinations in Michigan and Illinois. These generating plants formerly burned midwestern coal delivered by water. Rather than abandon existing equipment and construct rail lines and hopper car unloading facilities, these utilities may have found it advantageous to receive Montana coal by water.[43] Further, they may anticipate switching back to high-sulfur midwestern coal once sulfur scrubbers become operational.

The future is uncertain for the rail-to-water transfer of Montana coal. It has been suggested that the Port of Lewiston, Idaho, may serve as a gateway for the water transportation of coal to the northwest. This market appears limited, however, and significant volumes would depend on constructing electric generating plants or other coal-burning facilities on the Columbia River. Further, most sites in the northwest are already served by railroads, which would probably offer attractive rates for an all-rail transportation plan.

Turning to the eastern markets for Montana coal, the prospects for water transportation is equally uncertain. The ideal route would have unit trains carry coal to the Minneapolis area for transfer to barges for the trip down the Mississippi River. Theoretically, this would open the Mississippi-Missouri-Ohio River systems to Montana coal. But, there

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[43]J.G. Asbury and K.W. Costello, "Price Availability of Western Coal in the Midwest Electric Utility Market" (Argonne, Illinois: Argonne National Laboratories, 1974), p. 25.

appears to be concern that portions of the Mississippi River system may already be operating at or near capacity and be unable to handle significant amounts of coal. The existing locks and dam at Alton, Illinois, are often mentioned as the major bottleneck; these facilities are scheduled for replacement but have encountered opposition by environmental groups. Shipments of coal to St. Louis, Missouri, or some other port on the lower Mississippi downstream from the locks, would probably originate in Wyoming because of shorter rail distances. There are, however, a number of electric generating plants in Wisconsin and Iowa along the upper Mississippi River which may be supplied by barge.

Electric Transmission Lines

Electric transmission lines are an alternative to unit trains or slurry pipelines for exporting energy from Montana. Instead of transporting coal, electricity may be generated at mine-mouth plants and carried from the state on systems of transmission lines.

Electric energy may be transported in the form of either direct current (DC) or alternating current (AC). Direct current transmission lines are conceptually similar to coal slurry pipelines; they are very efficient in moving large amounts of energy between two distant points. But, they require expensive converters at the generating site to transform alternating current into direct current to be fed into the transmission system and inverters at the receiving station to change the electricity back into alternating current.[44] The efficiency of direct current transmission

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[44] Montana Department of Natural Resources and Conservation, *Draft Environmental Impact Statement on Colstrip Generating Units 3 and 4, 500 Kilovolt Transmission Lines, and Associated Facilities* (Helena, Montana, 1974), Vol. 4, Transmission Lines, p. 20.

result from lower costs for materials and construction because a ground return can be used and less line loss (the dissipation of electricity into the air and other conductors).[45] Transmission lines carrying alternating current, on the other hand, are somewhat less efficient but can be easily connected with existing transmission lines, allowing energy to be diverted to intermediate points.

The choice between direct or alternating current transmission lines mostly depends on the distance between the generating plant and the load center. Up to about 500 miles, the lower terminal costs of alternating current transmission lines--converters and inverters are not required--more than compensate for the other factors and leads to lower transportation costs.[46] For distances over 500 miles, however, the efficiencies of direct current systems dominate and make them the most economical. Tapping a direct current line at an intermediate point along the route and diverting some of the electricity would, of course, require an additional inverter and may increase the cost of this system relative to alternating current transmission. As a result of these restrictions, there is only one operational direct current transmission system in the United States; a 846 mile line from Oregon to Los Angeles, California.[47]

In Montana, direct current transmission lines may be appropriate if the entire output of an electric generating plant were destined for a distant load center. An alternating current system, may, on the other hand, be chosen if a portion of the electricity were to be consumed in the state and the remainder exported.

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[45] *Ibid.*, pp. 20-25.

[46] *Ibid.*, p. 26.

[47] *Ibid.*, p. 27.

Transmission lines may fail. If a load center is served by only one line, an outage would lead to a total loss of electricity. Consequently, transmission systems usually include alternative lines. The addition of a second line of equal capacity reduces the probability that both would experience simultaneous failures and increases the reliability of a system. A third line would further improve reliability, but the increment would be less than proportionate.[48] Therefore, building a transmission system from scratch usually involves the construction of two lines, preferably over different routes.

Opposition to transmission lines is often based on the potential impact on land use. The amount of land permanently displaced by a transmission line is relatively small; the towers for a 410 mile transmission line occupy a total of about 50 acres.[49] But, land will be required to provide access to the line along the right-of-way. Some additional land will be disturbed during construction, but most will probably return to its former condition if proper precautions are taken.

Land permanently displaced may understate the impact of transmission lines. Spray irrigation with radial systems cannot be used in fields transversed by transmission lines, reducing the potential yield of this agricultural land.[50] To minimize the impact on irrigated land, the right-of-way could be routed along section lines or existing roads. This may, however, significantly increase the costs because larger, stronger, and more expensive towers would be required each time the line makes a short

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[48] *Ibid.*, p. 16.

[49] Michael J. Murphy, Susanne Maeder, and James I. McIntire, *Northern Great Plains Coal: Conflicts and Options in Decision Making*, pp. 6-22.

[50] *Ibid.*

turn. Some of the adverse environmental impacts of transmission lines can be avoided if they are buried underground; this may, however, increase costs by two- to six-fold.[51]

Electric transmission lines have only a small economic impact on the local economy. During the construction phase, some additional employment opportunities may be created along the route, with a significant proportion being filled by local residents.[52] In the case of the proposed 500 KV lines associated with Colstrip Units III and IV, the construction of a 110 mile segment is projected to require 300 workers for about six months. Once in operation, transmission lines employ only a few maintenance workers scattered along the route. Transmission lines are liable for property taxes levied by counties, cities, and other taxing jurisdictions through which they pass. The assessed value of the entire electric utility is determined by Montana Department of Revenue and then allocated back to the appropriate taxing jurisdiction.

The planned additions to Montana's electric transmission system to 1984 are summarized in table 2.6. The current (November 1976) status of each project before the Montana Board of Natural Resources and Conservation, which must approve transmission lines of 100 KV or larger, is also shown.

The Colstrip to Hot Springs 500 KV line, associated with the proposed Colstrip generating Units III and IV, is the only major new electric transmission system planned for the state. In the event that these generating plants are not built, there are contingency plans for a 230 KV

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[51]Montana Department of Natural Resources and Conservation, *Draft Environmental Impact Statement on Colstrip Generating Units 3 and 4*, Volume 4, Transmission Lines, p. 37.

[52]*Ibid.*, p. 43.

Table 2.6

Planned Electric Transmission Lines in Montana
to 1984

Terminal Locations in Montana	Length of Line (Miles)	Voltage (Kilowatts)	Scheduled Completion	Status as of November 1976
Colstrip and Hot Spring	430	500	1980-1981	Approved by Montana Board of Natural Resources and Conservation. Currently the associated generating plants are under review by U.S. Environmental Protection Agency.
Billings and Anaconda[a]	220	230	1979-1981	No application received.
Great Falls and Cut Bank	95	115	1980	No application received.
Broadview and Alkale Creek	18	230	1977	Application made. Pending before Montana Board of Natural Resources and Conservation.
Broadview and Glengarry	118	100	1978	Application made. Pending before Montana Board of Natural Resources and Conservation.
Anaconda and Hamilton	61	161	1979-1980	Application made. Pending before Montana Board of Natural Resources and Conservation.
Clyde Park and Dillon	145	161	1978-1980	Application made. Pending before Montana Board of Natural Resources and Conservation.
Libby and Noxon[b]	70	230	1982	No application received.

Sources: Western Systems Coordinating Council, *Reliability and Adequacy of Electric Service; Reply to Federal Power Commission Docket R-362* (Denver, 1975), pp. 5-6 to 5-18; and The Montana Power Company, unpublished data (Butte, Montana, 1976).

[a]Will not be built if Colstrip Units III and IV and 500 KV lines are approved.

[b]Operated by Bonneville Power Administration.

line from Billings to Anaconda. Five smaller transmission lines are planned, with four applications already submitted, to accommodate projected electric demand growth within Montana; these lines are scheduled to be constructed between 1977 and 1980. Finally, the Bonneville Power Administration plans a 230 KV line in the western portion of the state connecting Libby and Noxon, to be completed about 1982.

III

PROPOSALS TO SUPPLY PETROLEUM AND NATURAL GAS TO MONTANA

The United States was not alone in revaluating energy resources following the 1973-1974 international crisis. In Canada, the National Energy Board (NEB) concluded that domestic users should be given first priority to the dwindling reserves of crude oil and natural gas and announced a policy of exporting only surplus quantities of these resources. For all practical purposes, this policy will result in the phased elimination of Canadian crude oil and natural gas to Montana and the rest of the United States. Fortunately, Alaskan crude oil and natural gas may be available at about the same time as the Canadian sources dry-up. There are a number of alternative proposals to transport these resources from Alaska to the continental United States. This section first examines Montana's dependence on Canadian natural gas and crude oil to place the problem into perspective. Then, the various proposals for distributing the replacement resources are examined in terms of their impact on Montana.

Montana's Dependence on Canadian Energy Sources

Montana currently imports from Canada approximately one-half of its natural gas and approximately 43 percent of the crude oil refined in the state. As shown in table 3.1, about 41,303 million cubic feet of natural gas came from Canada during 1975, compared to a total state supply of 83,500 million cubic feet. These figures are statewide totals, however, and do not tell the whole story. The Montana Power Company, representing about two-thirds of total sales of natural gas, was the major importer;

Table 3.1

Supply of Natural Gas, by Source in Montana
1971-1975

Year	Total Supply		Net Canadian Imports		United States Sources	
	Cubic Feet (000,000)	*Percentage of Total*	Cubic Feet (000,000)	*Percentage of Total*	Cubic Feet (000,000)	*Percentage of Total*
1971	104,283	*100.0*	44,600	*42.8*	59,683	*57.2*
1972	96,805	*100.0*	48,600	*50.2*	48,205	*49.8*
1973	96,245	*100.0*	50,000	*52.0*	46,245	*48.0*
1974	91,322	*100.0*	47,152	*51.6*	44,170	*48.4*
1975	83,500[a]	*100.0*	42,197	*50.5*	41,303	*49.5*

Source: Terry Wheeling, *Montana Historical Energy Statistics* (Helena, Montana: Montana Energy Advisory Council, 1976), table 3.7 and 3.8. United States sources derived.

[a]Includes estimated net withdrawals from storage.

Canadian sources accounted for about 85 percent of their sales of natural gas during 1975.[1] Therefore, the impact of a Canadian curtailment may be felt most severely by The Montana Power Company, which serves the western two-thirds of the state and directly or indirectly supplies all the major cities except Billings.[2]

In eastern Montana, the Montana-Dakota Utilities also faces a natural gas crisis, but not due to Canadian policies. Rather, the problem is similar to that elsewhere in the United States; the discovery of new reserves have not kept pace with the demand for natural gas. The Montana-Dakota Utilities obtains natural gas from Montana, North Dakota, South Dakota, and Wyoming.

A variety of petroleum products are produced by the Montana refineries importing Canadian crude oil and, depending on the local demand for specific items, some are consumed in the state while others are exported. For example, about 15.5 million barrels of gasoline were manufactured in Montana during 1975; approximately 70 percent was sold in the state and the remainder shipped elsewhere.[3] On the other hand, even though precise statistics are not available, local demands for asphalt--a byproduct of refining certain types of crude oil--appear insufficient for the Montana production, and most is exported.

A rough measure of Montana's dependence on imported petroleum may be derived by examining the sources of crude oil refined in the state. The

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[1]Terry Wheeling, *Montana Historical Energy Statistics*, tables 3.8 and 3.9.

[2]The Great Falls Gas Company and several other small utilities purchase natural gas from The Montana Power Company.

[3]Terry Wheeling, *Montana Historical Energy Statistics*, table 4.8.

data presented in table 3.2 shows that about 43 percent of the approximately 48 million barrels of crude oil refined in Montana during 1975 came from Canadian sources, slightly below the maximum figure of almost 50 percent in 1973. The three large refineries near Billings, which account for almost 90 percent of the refining capacity in the state, received between 37 and 54 percent of their crude oil from Canada.[4]

In summary, Canada supplies a significant portion of Montana's natural gas and crude oil. If no replacements are found, the curtailment of these imports will have a serious impact on Montana's economy. A recently completed study concluded that between 1,620 to 2,260 Montana jobs would be lost due to the direct and indirect effects of refinery shutdowns associated with the loss of Canadian crude oil; this figure does not include the additional consequences of reduced supplies of petroleum products and/or higher prices.[5] Similar estimates have not been prepared for natural gas; the potential impact may be even greater, however, because a larger share is imported from Canada.

Petroleum Supply Alternatives for Montana

The curtailment of Canadian crude oil is not a problem for just Montana; it is part of the nationwide petroleum crisis. Refineries throughout the Northern Tier states (Washington, Montana, North Dakota, Minnesota, Wisconsin, and Michigan) received about 50 percent of their crude oil from Canada during 1975.[6] The importance of Canadian imports is accentuated

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[4] *Ibid.*, table 4.5.

[5] Paul E. Polzin, *The Economic Importance of Montana Refineries and Projected Impacts of Curtailment in Canadian Petroleum Imports* (Helena, Montana: Montana Energy Advisory Council, 1976), pp. 1-3.

[6] U.S. Federal Energy Administration, Office of Regulatory Programs, *Pilot Study: Northern Tier Curtailment* (Washington, D.C., January 1976), table 1.

Table 3.2

Crude Oil Refined in Montana, by Source
1971-1975

Year	Total from All Sources (000 Barrels)	Sources of Crude Oil: Montana Barrels (000)	Montana *Percentage of Total*	Wyoming Barrels (000)	Wyoming *Percentage of Total*	Canada Barrels (000)	Canada *Percentage of Total*
1971	44,997	9,262	*20.6*	19,732	*43.8*	16,003	*35.6*
1972	48,591	8,194	*16.9*	19,241	*39.6*	21,156	*43.5*
1973	50,967	8,437	*16.5*	18,235	*35.8*	24,295	*49.7*
1974	48,053	7,989	*16.6*	16,949	*35.3*	23,115	*48.1*
1975	48,157	8,002	*16.6*	19,465	*40.4*	20,690	*43.0*

Source: Terry Wheeling, *Montana Historical Energy Statistics* (Helena, Montana: Montana Energy Advisory Council, 1976), table 4.5.

by the projected declines in the production of crude oil from local sources as well as growth in the consumption of petroleum products.

The nationwide impact of the Canadian petroleum policy has both advantages and disadvantages for Montana. The involvement of the large industrial states and the federal government suggest that resources, expertise, and international political pressure far in excess of the capabilities of Montana will be allocated to this problem. On the other hand, the final solution may be determined on the basis of national or regional priorities and may not be the one best suited for Montana.

The scheduled reduction in crude oil exports to the United States is determined by the National Energy Board based on their analysis of Canadian demand and supply of petroleum products. The current plan is shown in table 3.3 and calls for a complete elimination of these exports by 1982. The exact figures may change, however, depending on the annual review conducted by the National Energy Board.[7]

Nearly all projections show a decrease in the production of crude oil in the continental United States. The major new domestic sources are Alaska and offshore sites in the Atlantic, Pacific, and Caribbean Oceans. The offshore crude oil is likely to be directed toward refineries along the coasts. This leaves only Alaskan and foreign crude oil to supply the Northern Tier states.

Replacing Canadian with Alaskan or foreign crude oil is not simple and straightforward. Most refineries are designed for a specific type of crude oil. Substituting another crude oil may lead to different mix of

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[7] U.S. Federal Energy Administration, Office of Oil and Gas, *Crude Oil Supply Alternatives for the Northern Tier States,* A Report prepared for the Committee on Interior and Insular Affairs of the Senate and the House of Representatives (Washington, D.C., August 1976), pp. 3-4.

petroleum products.[8] If high-sulfur Alaskan crude oil is introduced, a relatively greater amount of residual fuel oil and/or asphalt will be produced, for which there is only a limited local market. These refineries may add additional facilities to further process the "low end" products, but this would require significant investments and two to four years for construction.

Replacement crude oil (either Alaskan or foreign) will be available on the coast areas while the refineries with excess capacity due to the Canadian curtailment are mostly in the interior of the country. A new transportation system must be built to carry the replacement crude oil inland because the existing distribution network in the Northern Tier states is primarily designed to bring crude oil south from Canada.

In Montana, the problem is one of transporting crude oil rather than the supply of crude oil. At issue is the most economical means for transporting the types of crude oil required to replace the predominately low-sulfur Canadian imports now used. New pipelines are the long-term solution for transporting Alaskan or foreign crude oil from the coast. But, these pipelines are major undertakings and, considering the delays due to construction and/or obtaining the approvals from the appropriate government agencies, would not be in operation before 1980 at the earliest. Glancing back at the scheduled curtailment shown in table 3.3 suggests there may be serious problems in 1978, or even as early as 1977. Therefore, there

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[8]Bonner and Moore Associates, Inc., *Petroleum Supply Alternatives for the Northern Tier States* (Houston, Texas, 1976), Volume III, Short Term Report, pp. 3-2 to 3-18.

Table 3.3

Actual and Projected Canadian Crude Oil Exports to the United States

Year	Barrels (000)
1971	263,165
1972	312,440
1973	365,305
1974	288,715
1975	219,000
1976	169,725
1977	93,075
1978	60,590
1979	31,025
1980	20,075
1981	1,825
1982	0

Source: U.S. Federal Energy Administration, Office of Oil and Gas, *Crude Oil Supply Alternatives for the Northern Tier States*, A Report for the Committee on Interior and Insular Affairs of the Senate and the House of Representatives (Washington, D.C., August 1976), p. 1.

is also the short-run problem of supplying the Montana refineries during the period when the new pipelines are being constructed.

Long-Term Supply Alternatives

The long-run solutions to alleviate the shortage of crude oil in the Northern Tier states may be classified into two broad categories. The first group includes proposals to transport Alaskan and foreign crude oil from the Pacific coast. The other group includes projects designed to move Alaskan, domestic, and imported crude oil north from the gulf coast.

Sohio-Plus, Loop, and Seadock. As shown in figure 3.1, the Sohio-Plus alternative includes a new tanker terminal in southern California and pipeline to connect with an existing natural gas pipeline, which will be modified to transport crude oil, to Midland, Texas.[9] Alaskan and foreign crude oil may be shipped from Midland through Tulsa, Oklahoma, to Minneapolis/St. Paul and Superior, Wisconsin, via a proposed expansion in the Williams Pipeline.

The Loop (Louisiana Offshore Oil Port) proposal includes a deepwater port near St. James, Louisiana, to supply crude oil through an expansion of the Capline Pipeline to Patoka, Illinois, and then via a new pipeline to Minneapolis/St. Paul. Seadock, on the other hand, locates the deepwater port off the Texas coast and utilizes the Texoma, Seaway, Explorer, and an expanded Williams Pipeline to supply the great lakes area and Minneapolis/St. Paul.

Finally, two pipelines have been proposed for the Central American isthmus, one crosses Guatemala and the other is in the Canal Zone of

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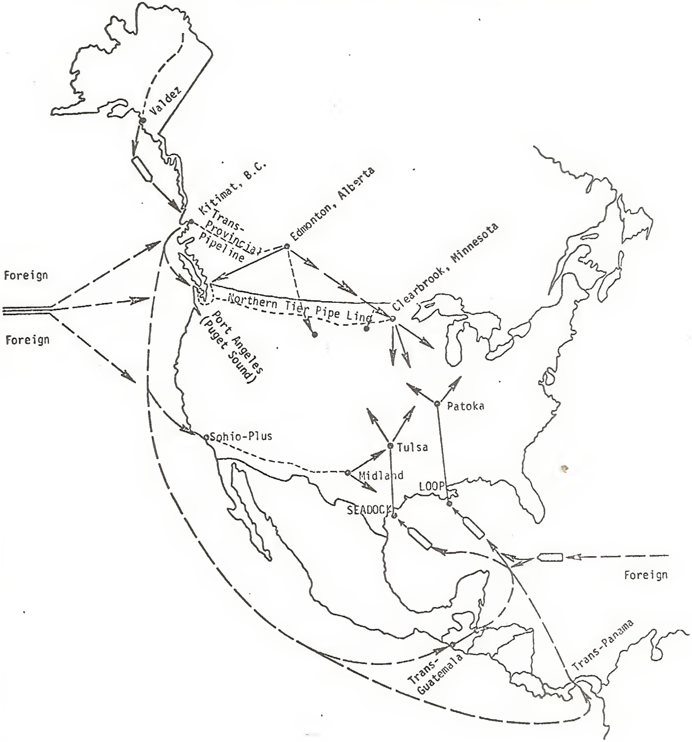
[9] U.S. Federal Energy Administration, *Crude Oil Supply Alternatives for the Northern Tier States*, pp. 48-49.

Figure 3.1

Long-Term Crude Oil Supply Alternatives for the Northern Tier States



Source: Bonner and Moore Associates, Inc., *Crude Oil Supply Alternatives for the Northern Tier States* (Houston, Texas: July 1976), Volume I, Executive Summary, p. 2-5.

Panama. Both would utilize deepwater terminals on the Pacific shore to accommodate very large crude container (VLCC) tanker ships.[10] On the Caribbean side, smaller tankers would probably be used to bring the crude oil to the gulf coast.

None of these alternatives were designed specifically to solve the problem in the Northern Tier states. They are primarily intended to provide an access to the midwest and gulf coast for Alaskan crude oil and as a means for using very large crude containers (VLCC) to provide economical transport of foreign crude oil to the United States. There would be no direct benefits to refineries in Montana except to the extent that midwest refineries would have a new source of supply, thereby eliminating their need for Wyoming and Montana crude oil. As will be discussed later, the potential benefits for Montana refineries may be small because of the limitations of the existing pipeline systems and the characteristics of Wyoming crude oil.

An engineering firm has suggested a small pipeline from Puget Sound to supply Alaskan or foreign crude oil to Billings--this may be the Plus in the Sohio-Plus alternative.[11] This pipeline is not part of the original proposals and should be considered very speculative; no sponsors have been announced, few details have been provided, and the economic feasibility has not yet been documented.

<u>The Northern Tier Pipeline</u>. This alternative, prepared by a Montana corporation, envisions a new 1500 mile pipeline from the Puget Sound area

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[10] *Ibid.*, pp. 49-51.

[11] Bonner and Moore Associates, Inc., *Crude Oil Supply Alternatives for the Northern Tier States*, Volume II, Technical Reports, pp. 4-60 to 4-63.

to Clearbrook, Minnesota, providing a direct access to Northern Tier and midwest refineries for Alaskan crude oil. Indonesian, Persian Gulf, or other low-sulfur foreign crude oil could also be unloaded at the terminal and introduced into the pipeline. As shown in figure 3.1, the proposed pipeline will cross Montana from west to east. The exact route through the state has not been finalized; one proposal follows the Burlington Northern highline while the other is slightly to the south and utilizes portions of the Milwaukee Road right-of-way.[12] In either case, direct access to the Billings area refineries would be provided via the Glacier Pipeline (not shown in figure 3.1), which crosses both of the proposed routes.

Current plans call for a 40 inch pipeline through Montana with an initial capacity of about 600 thousand barrels per day and an ultimate capacity of about 800 thousand barrels per day.[13] A 42 inch pipeline may be used in western Washington State if Puget Sound refineries are also supplied. The construction period will be about two years. The first oil could begin to flow in the third year after necessary approvals are granted by the appropriate government agencies. The total capital requirements of the pipeline and Puget Sound marine terminal are projected to be about $900 million (1976 dollars).[14]

The proposed Northern Tier Pipeline will cross Montana and lead to economic impacts during both the construction and operations phases. A recently completed study projected that during the two year construction period a total of 1,950 to 2,660 new jobs directly and indirectly associated

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[12] Butler Associates, Inc., *Northern Tier Pipeline Project; Engineering and Technical Evaluation Interim Report* (Tulsa, Oklahoma, April 1976), Section IV.

[13] *Ibid.*, Section III.

[14] *Ibid.*, Section VII.

with this project would be created in Montana.[15] Once the pipeline is built, there would be a permanent increase in employment (total direct and indirect) of about 48 to 63 jobs. The additional tax payments to the State of Montana, counties, cities, and other jurisdictions have not been estimated.

Transportation costs are an important consideration in evaluating supply alternatives because Montana is a consumer of crude oil and, unlike the case with coal, will bear the burden of these added payments. The proposed Northern Tier Pipeline calls for a capacity larger than is required to supply the refineries in the Northern Tier states.[16] The additional crude oil is intended for great lakes area and other eastern refineries, where it would face competition from crude oil shipped from other areas. If this demand does not materialize and the pipeline is operated at less than capacity, there would be a corresponding increase in per unit transportation costs. At its stated capacity, the estimated transportation costs for Alaskan crude oil including tanker costs are $.99 per barrel to Billings and $1.33 per barrel to Clearbrook.[17] An alternative pipeline with a capacity of about 400 thousand barrels per day, sufficient to supply the estimated demand of Northern Tier refineries, was estimated to have transportation costs of $1.05 per barrel to Billings and $1.33 to Clearbrook. The costs per barrel of operating the larger pipeline at less than capacity have not been estimated.

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[15] Paul E. Polzin, *The Economic Importance of Montana Refineries and Projected Impacts of Curtailments in Canadian Petroleum Imports*, p. 35.

[16] U.S. Federal Energy Administration, *Crude Oil Supply Alternatives for the Northern Tier States*, p. ix.

[17] Bonner and Moore Associates, Inc., *Petroleum Supply Alternatives for the Northern Tier States*, Volume II, Technical Report, pp. 4-16 and 4-17.

The proposed Northern Tier Pipeline could be delayed because of the court challenge of the Washington State law regulating the size of tankers entering Puget Sound.[18] There is also the possibility of a court challenge to the proposed terminal on Puget Sound and a federal environmental impact statement may be required. Allowing two years for these issues to be resolved (and assuming they are favorable to the pipeline proposal), construction could begin in 1979 and, if no significant delays are encountered, the first crude oil may flow in 1981. The Northern Tier Pipeline would not be subject to the present Montana Utility Siting Act.

The Northern Tier Pipeline Company consists of an Oklahoma engineering firm, the Curran Oil Company of Great Falls, subsidiaries of the Burlington Northern and the Milwaukee Road, and several other companies. These participants do not own Alaskan crude oil nor do they have an interest in the refineries to be served by the proposed pipeline. Because they are not associated with large oil companies, their efforts to raise capital should not be hindered by the threat of possible federal government action on vertical diverstiture in the oil industry. On the other hand, their apparent independence of the petroleum establishment may be a disadvantage because the major refineries in the Northern Tier states have not announced their support for this pipeline.

<u>The Trans-Provincial (Kitimat) Pipeline</u>. As shown in figure 3.2, this crude oil supply alternative proposes an 800 mile pipeline from a deepwater terminal at Kitimat, British Columbia, to Edmonton, Alberta.[19] The crude

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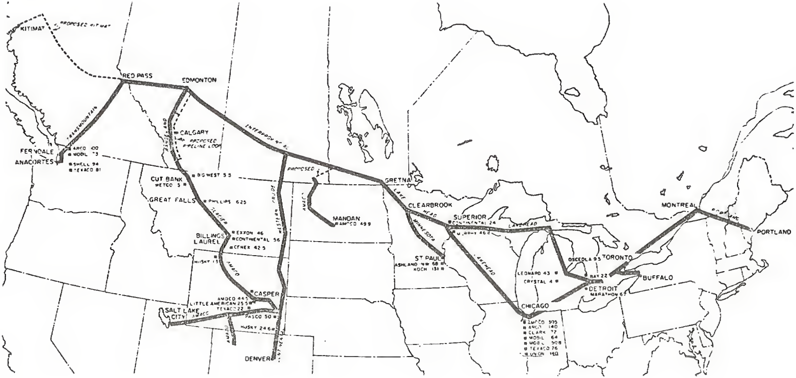
[18] U.S. Federal Energy Administration, *Crude Oil Supply Alternatives for the Northern Tier States*, p. xiv.

[19] Bonner and Moore Associates, Inc., *Crude Oil Supply Alternatives for the Northern Tier States*, Volume II, Technical Report, p. 4-30.

Figure 3.2

Proposed Trans-Provincial (Kitimat) Crude Oil Pipeline System



Source: John R. Hall, Executive Vice President of Ashland Oil, Inc., Prepared Statement before the Joint Committee of the United States Congress, Minneapolis, MN, September 13, 1976.

oil would then flow to Minnesota over the Interprovincial Pipeline, which currently has an excess capacity of about 400 thousand barrels per day. Both Alaskan and foreign crude oil may be unloaded at the Kitimat terminal and introduced into the pipeline.

The Trans-Provincial proposal does not provide for supplying crude oil to Montana; it includes only the marine terminal at Kitimat and the pipeline to Edmonton. There is a proposal, however, to install a new pipeline parallel to portions of the Rangeland system (a process called looping) south from Edmonton and connect to the Glacier Pipeline, bringing Alaskan or foreign crude oil to Montana refineries over existing pipelines.[20] This project is only in the planning stage; it is estimated to require about 60 miles of new pipeline with total costs of about $6.1 million.[21] This pipeline is independent of the Trans-Provincial proposal; sponsors must be found, financing arranged, and the appropriate permits obtained. Even though the plans have not been finalized, Montana refineries are confident that the Trans-Provincial Pipeline may be used to provide for a flow of crude oil to the state.

Announced participants and potential owner-shippers of the proposed Trans-Provincial Pipeline include two Canadian pipeline companies and several major United States oil companies with refineries in the Northern Tier states. As expected, most Northern Tier refineries have announced their support for this proposal. During normal times, the large oil companies would have little trouble finding the $400-500 million required

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[20] John R. Hall, Executive Vice President of Ashland Oil, Inc., Prepared Statement before the Joint Economic Committee of the United States Congress, Minneapolis, Minnesota, September 13, 1976.

[21] Bonner and Moore Associates, Inc., *Crude Oil Supply Alternatives for the Northern Tier States*, Volume II, Technical Report, p. 4-39.

for this project--approximately one-half of the estimated costs of the proposed Northern Tier Pipeline. But, the possibility of vertical divestiture or other antitrust action by the United States government could cause uncertainties in the capital markets and lead to delays in obtaining necessary funds.

The Trans-Provincial Pipeline has received strong support from the states of Minnesota and Wisconsin. They cite the advantages of building only 800 miles of new pipeline (versus 1,500 miles for the proposed Northern Tier Pipeline) and using the excess capacity in the existing Interprovincial Pipeline.[22] These benefits may not accrue to Montana, however, because crude oil would be diverted south before the junction with the Interprovincial Pipeline. For example, the estimated transportation costs to Billings for Alaskan crude oil (assuming the expansion of the Rangeland Pipeline) is $1.54 to $1.80 per barrel, about $.55 to $.80 greater than for the Northern Tier Pipeline, while the corresponding figures to Clearbrook, are $1.31 to $1.57 per barrel, about the same as the Northern Tier Pipeline.[23] Since the Trans-Provincial Pipeline is intended only to serve refineries in the Northern Tier states, the estimated transportation costs do not require the additional uncertain demand from great lakes refineries. Therefore, Wisconsin and Minnesota may view the Trans-Provincial Pipeline as a means of obtaining transportation costs equivalent to the Northern Tier Pipeline, but with less risk.

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[22] John P. Millhone, Director, Minnesota Energy Agency, Prepared Statement before the Joint Economic Committee of the United States Congress, Minneapolis, Minnesota, September 13, 1976. Charles Cicchetti and John H. Loewy, "Analysis and Recommendations of Northern Tier Pipeline Proposals," Mimeographed (Madison, Wisconsin: Wisconsin Office of Emergency Assistance, July 1976).

[23] Bonner and Moore Associates, Inc., *Crude Oil Supply Alternatives for the Northern Tier States*, Volume II, Technical Report, pp. 4-40 to 4-43.

The estimated construction time for the marine terminal and the Trans-Provincial Pipeline is about two years, approximately the same as for the proposed Northern Tier Pipeline.[24] All permits are granted by a single agency, the National Energy Board of Canada, and the necessary authorizations could be obtained in about one year.[25] The Canadians may view this proposal favorably because it would allow full utilization of the Interprovincial Pipeline, leading to lower per unit transportation costs, and Canada would be provided with a west coast deepwater port capable of unloading large tanker ships. If application were made early in 1977, approvals could be received by the end of the year and the first oil could flow in late 1979 or 1980.

The national security risks of a Canadian pipeline are relatively minor. The U.S. Department of State is currently negotiating a treaty with Canada to assure that the flow of crude oil would not be arbitrarily interrupted.[26] In addition, Canada now depends on crude oil flowing through the U.S.; for example, shipments from the Interprovincial Pipeline may continue on the Lakehead Pipeline through portions of several states before reentering Canada at Sarnia, Ontario, and the refineries near Montreal are supplied by a pipeline across New England.

Since the new pipeline and associated facilities will be in Canada, the proposed Trans-Provincial Pipeline will lead to little, if any, direct increase in Montana employment, earnings, or tax payments.

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[24] U.S. Federal Energy Agency, *Crude Oil Supply Alternatives for the Northern Tier States*, p. VIII.

[25] *Ibid.*, p. XV.

[26] *Ibid.*, pp. 42-43.

An intangible benefit of the Trans-Provincial proposal is its potential for improving United States-Canadian relations. Both countries appear to benefit and its approval over an all-American route may demonstrate our country's good faith in energy matters. An improvement in relations would certainly aid Montana in future negotiations with Canadian authorities concerning various energy-related topics.

Short-Term Crude Oil Supply Alternatives

New pipelines require two to three years before the crude oil begins to flow. At the earliest, therefore, it would be late 1979 before replacements for Canadian imports were available. Severe crude oil shortages may develop sooner. As was shown in table 3.3, total Canadian exports to the United States in 1977 are scheduled to decline by almost one-half from the 1976 level. Montana will probably be spared for about one year; Washington State refineries will switch to foreign crude oil and free Canadian crude oil to be allocated to the interior Northern Tier states during 1977. Beginning in 1978, the crude oil exports to Montana will decline in proportion to the national totals.

Short-term supply alternatives are those options which can be operational during the interim period when long term solutions are being developed but Canadian imports are further curtailed. Specifically, the short-term will be defined as the years 1977, 1978, and 1979.

Tank Car Unit Trains. Burlington Northern proposes to assemble unit trains of tank cars on the Oregon coast and transport Alaskan and foreign crude oil to Montana and North Dakota.[27] At Cut Bank, Montana, the trains

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[27] Bonner and Moore Associates, Inc., *Petroleum Supply Alternatives for the Northern Tier States*, Volume III, Short-Term Report, pp. 3-67 to 3-74.

could unload directly into the Glacier Pipeline to supply the Billings refineries. Similarly, the trains could unload at Tioga, North Dakota, and the crude oil transported to Mandan, North Dakota, via the Amoco Pipeline. Each train would consist of 90-95 newly-designed interconnected tank cars. The interconnections allow strings of cars to be loaded or unloaded simultaneously, decreasing the cost of this otherwise labor-intensive chore.

This plan could be operational (initially with small volumes) in six to nine months. The tanker ships could be unloaded using existing facilities at Port Westward, Oregon, a former U.S. Army supply base. The tank car unloading equipment at Cut Bank and Tioga require about six months to construct. The manufacturer of the tank cars could begin initial deliveries about six months after contracts are signed. Therefore, if the preparations are begun by January 1, 1977, this alternative could be ready to distribute Alaskan crude oil when it becomes available in late 1977.

The cost of transporting Alaskan crude oil to Billings via unit train and Glacier Pipeline is projected to be about $2.75 per barrel including an estimated $0.50 per barrel for tanker costs. This compares to $0.99 per barrel for the proposed Northern Tier Pipeline and $1.54 to $1.80 per barrel for the proposed Trans-Provincial Pipeline, when and if they are completed.[28] The rail cost may be reduced if the trains do not return empty to the west coast. It has been suggested a mixture of residual fuel and coal particles may be shipped from Montana to be used as boiler fuel in Puget Sound power plants and pulp and paper

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[28] *Ibid.*, Volume II, Technical Report, p. 4-17 and 4-42.

mills.[29] There will be an excess supply of residual fuels in Montana and North Dakota if these refineries process Alaskan crude oil. The elimination of the empty return trip for the unit trains could reduce the transportation costs to about $2.30 per barrel.[30]

The estimated transportation costs for unit train were based on a ten year amortization period for the tank cars and other facilities.[31] But, this supply alternative may not be viable for ten years; even if the worst should happen, the pipelines could be operational in about five years. If no alternative uses for the tank cars are found, a higher tariff would be required to amortize them in a shorter period. Further, the Burlington Northern may find it difficult to raise capital for crude oil unit trains at the same time it plans significant expenditures on the coal routes. At about $44,000 per car, each unit train would cost about $4.0 million; approximately seven or eight unit trains would be needed to supply Montana.[32] As with coal unit trains, however, the financing problems may be reduced if the rolling stock is leased by the railroad.

The additional traffic due to tank car unit trains may not require significant expenditures to upgrade existing rights-of-way. The Burlington Northern will probably use the highline to transport crude oil to Cut Bank and through Montana to North Dakota. An average of two to three trains per

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[29] *Ibid.*, Volume III, Short-Term Report, p. 3-73.

[30] *Ibid.*, p. 3-71.

[31] *Ibid.*, pp. 3-72 to 3-74.

[32] John Willard, Public Relations Manager, Burlington Northern, Billings, Montana, Personal Correspondence, October 21, 1976.

day (including empties) would be needed to supply Montana with 21,000 thousand barrels of crude oil per year, about the amount imported from Canada during 1975. In addition, an average of about one train per day (including empties) could supply North Dakota. This increase in traffic is within the capacity of the highline, which is equipped with Centralized Track Control over most of its length. Notice that crude oil shipments may not interfere with coal shipments to the northwest, which are not likely to reach significant volumes until the 1980's.

Crude Oil Exchanges. Crude oil may be delivered to the Northern Tier states in exchange for domestic crude oil transported to Canada. For example, Canadian crude oil may be shipped to Montana via the Rangeland Pipeline and an equal amount of U.S. crude oil may be delivered to Sarnia via the Lakehead Pipeline. This supply alternative would be ideal for Montana because the refineries would receive the type of crude oil they were designed to efficiently process.

Exchanges may occur if two refineries have access to crude oil with the appropriate qualities and when the U.S. crude oil is located such that it may be shipped to Canada and the Canadian crude oil may be exported to the United States. Since most crude oil pipelines flow south from Canada to the western United States while the opposite is true in the east, crude oil exchanges require careful preparation, planning, and negotiation.

Crude oil exchanges must be approved by the National Energy Board of Canada. Such exchanges, however, are outside the export quotas. So far, only three applications have been approved; they are for small volumes, short terms, and involve only secure supplies of United States domestic crude oil. In the longer run, the U.S. Department of State and the U.S. Federal Energy Administration favor crude oil exchanges for larger volumes,

longer terms, and U.S. owned but not necessarily domestic crude oil.[33] For example, offshore crude oil may be shipped to Montreal via the Portland Pipeline or Alaskan crude oil may be unloaded at Kitimat and transported to Canadian refineries. But, the long-run outlook for crude oil exchanges is not promising because the goal of Canadian policy is to reduce dependence on foreign energy.

Other Supply Alternatives

Montana's petroleum pipelines have limited flexibility to accommodate alternative sources of supply. The crude oil pipelines have north-south axes while the petroleum products pipelines radiate outward from Billings. There have been some suggestions, however, for modifications to redirect crude oil and refined products on the existing systems.

One proposal calls for reversing the pipeline south of Billings and transporting more Wyoming crude oil into Montana.[34] This pipeline currently carries Canadian crude oil and will have excess capacity due to the curtailment of imports. The refineries in Billings are limited in the amount of Wyoming crude oil they can process because of the high residual fuel and asphalt yield; the current level is already straining their ability to dispose of these byproducts.

An alternative approach envisions supplying a greater share of the petroleum consumption in eastern Washington via the existing Chevron Pipeline from Salt Lake City, Utah, to Spokane, Washington. This would allow more of the products now shipped into this area via the Yellowstone

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[33] *Ibid.*, Volume II, Technical Report, p. 2-14.

[34] *Ibid.*, Volume III, Short-Term Report, pp. 3-56 to 3-58.

Pipeline to remain in Montana. There is some doubt, however, whether the Salt Lake City refineries have the capacity or the crude oil to increase their supply to eastern Washington.

On the same vein, Denver could receive more petroleum products from Kansas via the Chase Pipeline. The product shipments from Casper to Denver would be reduced as would those from Billings to Casper. The Montana refineries could then retain more of the refined products for distribution within the state.

All of these proposed solutions involve complex and coordinated changes in contractual agreements, ownership of crude oil and petroleum products, and traditional marketing areas of the refineries. The individual oil companies may have to rely on a government agency, such as the U.S. Federal Energy Administration, to provide the incentive and initiative.

Alaskan Natural Gas Supply Alternatives

Montana does not face an immediate crises in the supply of natural gas. Although Canada may reduce exports in the future, no timetable or schedule has been devised. Instead, the Canadians are replacing the long-term purchase agreements with annual contracts, which may be renewed each year. Even though there may be cancellations, the U.S. Federal Energy Administration believes these contracts will continue to be renewed in the short-run.[35] The Montana Power Company now receives Canadian natural gas at the rate of 34.3 BCF (billion cubic feet) per year.[36] During May

[35] Frank G. Zarb, Administrator, U.S. Federal Energy Administration, Prepared Testimony before the Joint Economic Committee of the U.S. Congress, Minneapolis, Minnesota, September 13, 1976.

[36] William H. Coldiron, Executive Vice President, The Montana Power Company, Butte, Montana, Letter to Lt. Governor Bill Christiansen, May 18, 1976.

1977, this may be reduced to 29.2 BCF per year. The next major contracts will expire in 1985 and 1986. If they are not renewed, the volume will decline to about 14.6 BCF per year. Thererore, if there is no dramatic shift in Canadian policy, Montana has seven or eight years to plan for the replacement for Canadian natural gas. Even though the volumes of natural gas have not been severely restricted, the Canadians have increased the price of exports to the United States. During the last two years, the price of natural gas delivered at the border has risen from about \$1.00 to \$1.60 per MCF (thousand cubic feet), with a further increase to \$1.94 per MCF scheduled for January 1, 1977.

The Montana Dakota Utilities and the eastern portion of the state also face a serious natural gas supply problem. But, they do not have the possibility of sudden declines in supply due to Canadian curtailments.

The only major new discovery of domestic natural gas has been in the Prudhoe Bay area of northern Alaska. These reserves will not solve the nationwide shortage, however, because estimated annual production may equal only five percent of the 1975 national consumption of natural gas.[37] Nevertheless, the major issue concerns the most appropriate method for transporting the natural gas from the Artic to the consuming areas in the continental United States.

Natural Gas Transportation Proposals

Following the discovery of natural gas at Prudhoe Bay in 1968, a number of proposals were made by industry groups to transport the natural gas to the major markets in the continental United States. Only three

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[37] U.S. Department of the Interior, *Alaskan Natural Gas Transportation Systems*, A Report to the Congress Pursuant to Public Law 93-153 (Washington, D.C., December 1975), p. 4.

advanced beyond the planning stage, however, and have been formally submitted to the U.S. Federal Power Commission, which grants certificates for interstate gas sales and for the construction and operation of interstate pipelines, and/or the U.S. Department of the Interior, which is responsible for granting rights-of-way across federal lands.

The El Paso Alaskan System (figure 3.3). The El Paso system proposes an 800 mile gas pipeline south from Prudhoe Bay to Gravina Point, Alaska, on the existing right-of-way of the Alaskan (Alyeska) crude oil pipeline.[38] At Gravina Point, the natural gas would be liquified and loaded onto cryogenic tanker ships. The liquid natural gas (LNG) would be unloaded and gasified at Port Conception, California. About one-half of the natural gas would be directed into existing pipelines for distribution along the west coast. The remaining portion may be available either directly or by displacement to markets east of the Rocky Mountains. The El Paso application does not include a pipeline to the interior of the county.

The Arctic Gas Pipeline (figure 3.4). This proposal calls for a pipeline system through Canada to deliver Prudhoe Bay natural gas to the midwest and western areas of the United States.[39] The pipeline would also transport Canadian natural gas from the MacKenzie Delta to north of the United States border, where it would be diverted toward eastern Canada.

The Arctic Gas system consists of four projects. (1) The 195 mile Alaska-Artic pipeline from Prudhoe Bay to the Canadian border. (2) Canadian-Arctic gas, a 2,297 mile pipeline from the Canadian border east to the

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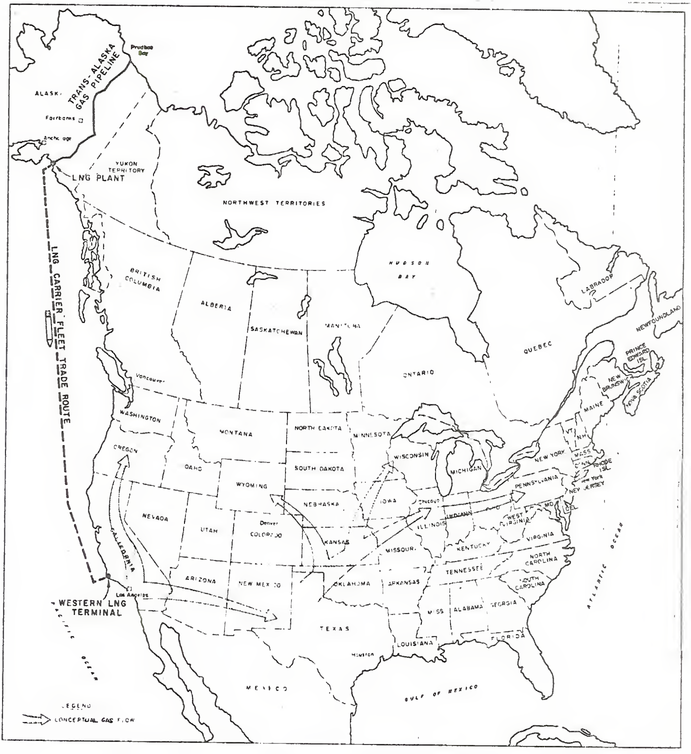
[38] U.S. Federal Power Commission Staff, *Final Environmental Impact Statement for Alaska Natural Gas Transportation Systems* (Washington, D.C., April 1976), p. I-A8.

[39] *Ibid.*, pp. I-A4 to I-A6.

Figure 3.3

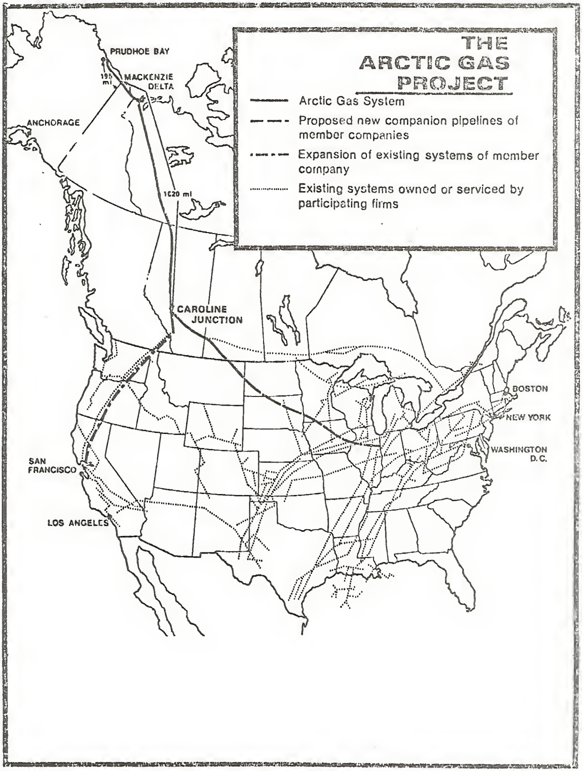
The El Paso-Alaska Natural Gas System



Source: Michael J. Murphy, *Transporting Artic Region Natural Gas to the 48 States* (Minneapolis, Minnesota: Upper Midwest Council, August 1976.

Figure 3.4

The Arctic Gas Pipeline



Source: Alaska Arctic Gas Pipeline Company (Washington, D.C.).

MacKenzie Delta, then south, dividing at Caroline Junction, Alberta, and terminating at Kingsgate, British Columbia, near the Idaho border, and Monchy, Saskatchewan, near the Montana border. (3) The Northern Border Pipeline, a 1,138 mile pipeline from the Canadian border through Montana, North Dakota, South Dakota, Minnesota, Iowa, and terminating near Chicago, Illinois. (4) Pacific Gas Transmission and Pacific Gas and Electric, a 874 mile pipeline expansion on existing right-of-way from the Canadian border through Idaho, Washington, Oregon, and terminating in California.

The portion of the Northern Border Pipeline through Montana is estimated to create a maximum of 560 short-term construction jobs.[40] Also, about 205 permanent positions, a figure which appears to be very large in light of the employment estimate for the Northern Tier Pipeline, are projected for the state. Total property taxes of this portion are projected to be about $4,500 per year.

The Alcan Pipeline (figure 3.5). This proposal was filed in July, 1976 and is the latest submitted to the U.S. Federal Power Commission. It may have been inspired by an alternative to the Arctic Gas Pipeline proposed in the FPC's environmental impact statement.[41] The distinguishing feature of the Alcan proposal is that it follows existing rights-of-way and includes expansion of pipelines whenever possible in order to minimize costs and environmental damage.

The Alcan Pipeline is a joint United States and Canadian project.[42] It includes a 730 mile pipeline from Prudhoe Bay south to the Canadian

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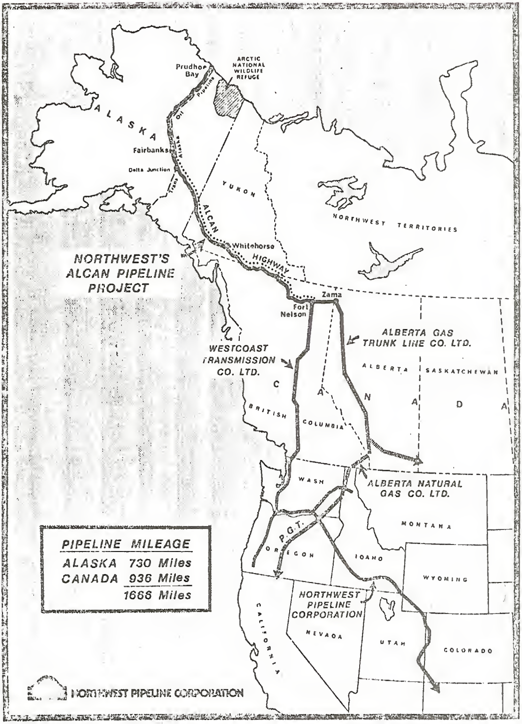
[40] U.S. Department of the Interior, *Alaskan Natural Gas Transportation Systems*, pp. 208-210.

[41] U.S. Federal Power Commission Staff, *Final Environmental Impact Statement for Alaska Natural Gas Transportation Systems*, p. I-A7.

[42] U.S. Federal Power Commission Staff, *Final Environmental Impact Statement for Alaska Natural Gas Transportation Systems, Alcan Pipeline Project Supplement* (Washington, D.C., September 1976), pp. 1-36.

Figure 3.5

The Alcan Pipeline



Source: Northwest Pipeline Corporation (Salt Lake City, Utah).

border; the first 539 miles to Delta Junction follow the Alaska Oil Pipeline (Alyeska) right-of-way and the remaining 191 miles are along the Alcan Highway. From the border, the proposed pipeline would continue on the Alcan Highway to Ft. Nelson, British Columbia, where it would divide. One route follows the Westcoast Transmission Company line south to Washington State while the other proceeds over new right-of-way to Zama Lake and connects with the Alberta Gas Trunk Line. The proposed route continues south through Alberta following existing pipelines and divides at Caroline Junction. One spur travels west to Kingsgate, British Columbia. The other proceeds east to Saskatchewan, where about 160 miles of new pipeline will be constructed to the Montana border. The routes through the United States from Kingsgate to California and Saskatchewan to Illinois are identical to those proposed for the Arctic Gas system. The Alcan Pipeline is not designed to transport natural gas from the MacKenzie Delta. A Canadian proposal to build the Maple Leaf Project, a gas pipeline along the MacKenzie River Valley to Zama Lake, may supply Canadian gas to Canadian consumers.

Comparison of the Natural Gas Transportation Proposals

The three transportation proposals were designed to deliver Alaskan natural gas to only selected regions of the county; the El Paso system will terminate in California and the two pipelines will ship most natural gas to the midwest, with smaller laterals to the west coast. Other areas of the country would benefit from the Alaskan natural gas through a displacement plan. For example, if the El Paso system is chosen, natural gas from the southwest currently flowing toward California could be diverted to the midwest or east. For the Arctic Gas and Alcan proposals, the Alaskan

natural gas delivered to the midwest may displace an equivalent volume from domestic sources, which may then be transported to other consuming areas.

The displacement concept will minimize the new pipelines required to distribute Alaskan natural gas. The plan will be implemented with exchange agreements; companies would receive Alaskan natural gas in exchange for natural gas from a source in the continental United States. Even though exchange agreements are common in the industry, the distribution of Alaskan natural gas will require larger and more complex agreements than have previously been negotiated. Whichever Alaskan natural gas proposal is chosen, the corresponding displacement plan must be approved by the U.S. Federal Power Commission and probably reviewed by the courts.[43]

The replacement concept is not well-suited to supply The Montana Power Company with Alaskan natural gas. In the first place, The Montana Power Company pipeline system is designed to distribute natural gas southward from the Canadian border and has no major links with other domestic sources. Secondly, and perhaps most important, exchange agreements usually involve a trade of natural gas. But, The Montana Power Company has nothing to trade to the owners of Alaskan natural gas and may have to rely on purchases, which may be difficult to arrange if other companies are reluctant to sell and reduce the potential supplies to their customers.

The Montana Power Company supports the Arctic Gas Pipeline.[44] They have purchase agreements with Pacific Gas and Electric Company, one of the sponsors of the project. If the west coast portion of the Artic Gas

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[43]U.S. Department of the Interior, *Alaskan Natural Gas Transportation Systems*, pp. 8 and 9.

[44]The following is based on discussions with William H. Coldiron, Executive Vice President, The Montana Power Company, Butte, Montana, November 1976.

Pipeline is built, delivery of Alaskan natural gas could be made through existing facilities near Glacier National Park. If this segment is not constructed, a new pipeline may be required to bring the gas from northeast Montana. In the event the El Paso system is chosen, one may speculate that there will be surplus gas in California and The Montana Power Company could make purchases from Pacific Gas and Electric to be delivered from their Canadian imports, which are not due to expire until 1993. The Montana Power Company has not studied the Alcan Pipeline proposal in detail; but since it has a smaller capacity than the alternatives, they believe purchases of natural gas may be difficult to arrange.

A direct comparison between the three Alaskan natural gas transportation proposals is difficult because they include many different options. A brief summary of selected features is as follows:

Capital costs. The El Paso system will cost about $8.0 billion, which does not include an additional $1.0 billion for a pipeline across the Rocky Mountains.[45] The Arctic Gas Pipeline is projected at approximately $8.3 billion; but $1.5 billion of this total may be attributed to the transportation of Canadian gas. The total cost of the Alcan Pipeline proposal will be about $4.6 billion, which does not include the pipelines into the midwest and the east. The low figure for the Alcan Pipeline is due to their emphasis on expanding (looping) existing pipelines rather than building from scratch.

Construction period. The El Paso and Arctic Gas systems would both require about five and one-half years for construction after the approval

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[45] Michael J. Murphy, "Transporting Artic Region Natural Gas to the 48 States," Mimeographed (Minneapolis, Minnesota: Upper Midwest Council, 1976).

by government agencies.[46] If the Arctic Gas System is chosen, some volumes of MacKenzie Delta natural gas may be delivered earlier to destinations in Canada. The sponsors of the Alcan Pipeline claim they could have Alaskan natural gas in United States markets within three years. But, this consortium has made only a basic application to the U.S. Federal Power Commission and has just begun certain key studies.[47]

Pipeline volumes. The El Paso System is designed to deliver about 3.5 billion cubic feet per day (BCFD) to the continental United States.[48] Similarly, the Arctic Gas Pipeline may transport approximately 3.5 BCFD of Alakan natural gas; in addition, between .5 and .9 BCFD of MacKenzie Delta natural gas may be shipped within Canada. The Alcan Pipeline is limited in its expansion capability and has a capacity of 2.5 BCFD, which will be entirely Alaskan natural gas.

Net national benefits. The U.S. Federal Power Commission and the U.S. Department of the Interior have evaluated the natural gas supply alternatives in terms of net national benefits; that is, the dollar value of the benefits from the consumption of Alaskan natural gas minus the costs, not including environmental costs, to the nation of producing and delivering the gas. This method takes a national viewpoint and may not explicitly consider the unique natural gas supply problems in Montana.

Net national benefits for the alternative supply systems under certain assumptions are presented in table 3.4. The exact figures are not as

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[46] U.S. Department of the Interior, *Alaskan Natural Gas Transportation Systems*, p. 6.

[47] Michael J. Murphy, "Transporting Artic Natural Gas to the 48 States," p. 3.

[48] U.S. Federal Power Commission Staff, *Final Environmental Impact Statement for Alaskan Natural Gas Systems, Alcan Pipeline Project Supplement, Part 2, Economic Analysis* (Washington, D.C., September 1976), table II-1.

Table 3.4

Estimated Net National Benefits Accruing from Selected Alaskan Natural Gas Supply Alternatives

Supply Alternative	High Supplies of Non-Alaskan Natural Gas: Net National Benefits[a] (000,000)	Rank	Low Supplies of Non-Alaskan Natural Gas: Net National Benefits[a] (000,000)	Rank
Artic Gas Pipeline[b]				
With western segment	$3,934	4	$6,614	3
Without western segment	4,238	2	6,904	2
El Paso System	4,041	3	6,199	4
Fairbanks Alternative[c]	4,275	1	6,962	1
Alcon Pipeline	1,740	5	3,702	5

Source: U.S. Federal Power Commission, *Final Environmental Impact Statement for Alaska Natural Gas Transportation Systems, the Alcon Pipeline Project Supplement, Part 2, Economic Analysis* (Washington, D.C., September 1976), table #-3.

Note: Supply alternatives are similar but not identical to the proposals submitted by the applicants.

[a]Net national benefits are the dollar value of the benefits from the consumption of Alaskan natural gas minus the costs, apart from environmental costs, to the nation of producing and delivering the gas. An alternative fuel price of $12 per barrel for crude oil is assumed.

[b]Based on MacKenzie Delta flow of .5 BCFD from 1982 to 1985 and .9 BCFD thereafter.

[c]Hypothetical alternative constructed by the U.S. Federal Power Commission staff.

important as their ranking and relative values. The Fairbanks Alternative, a hypothetical pipeline essentially following the Alcan route but with a greater capacity, ranks the highest. The net national benefits for the Arctic Gas and the El Paso proposals are nearly equal and both are significantly greater than for the Alcan Pipeline. The net national benefits for the Arctic Gas Pipeline are greater without the western segment, suggesting that the costs outweigh the benefits for this portion of the proposed system. Net national benefits were calculated for a number of alternatives using various assumptions. In all cases, the relative merits of the supply proposals were similar to those shown in table 3.4.

Current Status of the Natural Gas Transportation Proposals

The sponsors of the El Paso, Arctic Gas, and Alcan proposals have all filed before the U.S. Federal Power Commission for a certificate of public convenience. The last Congress passed a bill (S.B. 3521) directing the U.S. Federal Power Commission to complete the review of the alternatives and transmit a determination to the President by January 1, 1977 and allowing the President to make a decision by August 1, 1977.[49]

The U.S. Federal Power Commission and the U.S. Department of the Interior have completed final environmental impact statements for all three proposals. Selected findings of these studies are as follows:[50]

1) All three proposals are technically feasible and provide a viable method for transporting Alaskan natural gas to the continental United States.

2) The El Paso and Arctic Gas proposals traverse areas which are worthy of preservation.

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[49] Frank G. Zarb, Prepared Testimony before the Joint Economic Committee September 13, 1976.

[50] U.S. Federal Power Commission Staff, *Final Environmental Impact Statement for the Alaska Natural Gas Transportation Systems, Alcan Pipeline Project Supplement*, p. 389.

3) The Alcan proposal lacks expansion flexibility to accommodate additional volumes of natural gas likely to be available from the Prudhoe Bay area. Also, it requires a separate pipeline system to transport MacKenzie Delta natural gas (the Maple Leaf Pipeline) to consuming areas in Canada.

4) If one of the applicant's proposals is to be selected, the Arctic Gas pipeline should be certified. But, without the western segment, which is favored by The Montana Power Company, because of unfavorable benefit/cost considerations.

5) The U.S. Federal Power Commission environmental staff strongly support a hypothetical proposal they designate as the Fairbanks Alternative. This route would be similar to the Alcan Pipeline in that it follows the Alaskan Pipeline to Fairbanks and then proceeds along the Alcan Highway. There is no segment to the west coast and the MacKenzie Delta may be served by an optional lateral. Unlike the Alcan proposal, this pipeline would be built from scratch with a capacity similar to the Arctic Gas and El Paso systems.

The National Energy Board of Canada has received an application for the Arctic Gas system. The Alcan Pipeline proposal may not yet have been submitted to the Canadian authorities. A preliminary staff report concludes the Arctic Gas proposal would disturb unique areas in the northern Yukon and suggests an alternative route similar to the Fairbanks Alternative with a lateral to the MacKenzie Delta to transport the Canadian natural gas.[51] The National Energy Board has not announced when its final decision will be made.

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[51] *The Energy Daily*, Vol. 4, No. 99 (November 3, 1976), p. 4.